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New Wire Rope Grip for Brooklyn Bridge.

The engravings which we present with this represent a new grip for connecting cars with the moving rope or cable in the system of wire rope traction, of which an example is that used on the Brooklyn Bridge. Of these engravings, Fig. 1 is a general plan; Fig. 2 a sectional elevation on line *a b* (Fig. 1); Fig. 3 a side elevation, and Figs. 4 and 5 detached views of one of the dies and one of the guides, respectively. In all the figures, similar letters are used to designate the same parts. By the operation of this grip it is proposed to hold the rope for propelling the car, without subjecting it to damaging pressure, and to permit the car to be moved when desirable at any velocity less than that of the rope, without subjecting the latter or the parts of the grip to destructive wear.

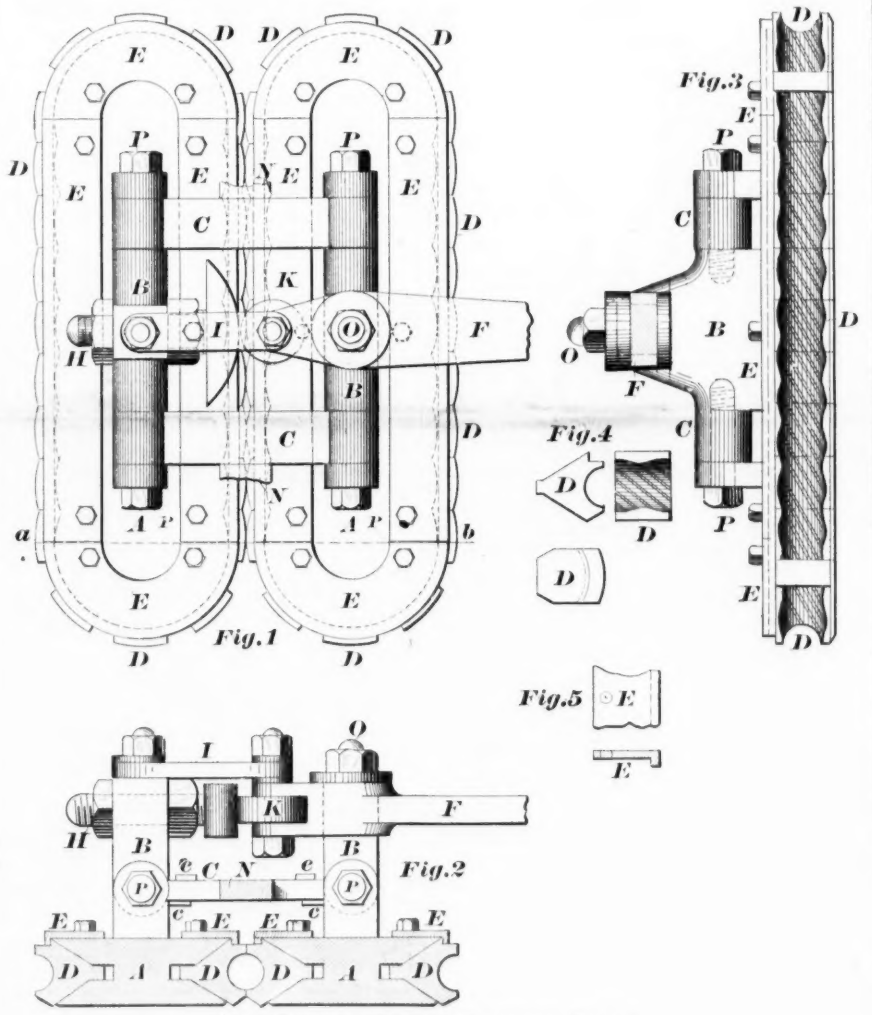
Referring to the engravings, *A A* are oblong movable jaws, about the entire circumference of which are V grooves or ways, to which are fitted the dies *D*. These dies are held in place by the guides *E*, which leave them free to move around the jaws in the ways. The semicircular faces of these dies are corrugated in such a way as to correspond with the spiral of the rope, so that when the dies are arranged on opposite sides of the rope, with the blank portion of their faces in contact, they will conform to the entire circumference of the rope, similar to a divided nut to a bolt.

The jaws *A* are connected together by the links *C*, attached to projections *B*, on the jaws, and swing on the hinge bolts *P*. The lever *F*, by which the jaws are moved, has its fulcrum *O* upon the extension of one of the jaws, and is connected with the other by means of a link *I*. The end of the lever is provided with a roller *K*, which bears upon the head of the thrust screw *H*. By a consideration of this construction, which is clearly shown in the engraving, it will be understood that by moving the lever *F*, which is conveniently extended for the purpose, the parts *A* may, according to the direction in which the lever is moved, be brought towards each other, or separated.

As will be inferred, the rope when in position to move the car is held between the two series of dies. In this condition, and when no more force is employed on the lever than sufficient to bring the dies together, the latter will, by the motion of the rope, be carried around their respective jaws, moving in the V ways comparatively without friction. A further application of force to the lever will establish friction between the dies and the ways, which may be increased gradually or suddenly, as may be desired, until it is sufficient to move the car at the same velocity as the rope. Of course when the car has attained its maximum velocity, the dies no longer slip in the ways, but when being moved slower than the rope the slip is in proportion to the difference in the speed between the two. In stopping the car, the grip can similarly be either gradually or suddenly released; or at any time when desired the grip can be loosened so that the dies will slip and the car be moved at as slow speed as is desired. In neither gradually or suddenly connecting, nor in running under any conditions, is there then any slipping of the rope through the dies, neither is there any material pressure brought against the circumference of the rope, however hard the surfaces of the ways and dies may be forced together.

Such wear as there may be comes upon large wearing surfaces, sufficient to produce the required friction without excessive pressure, and moreover the parts subject to wear are comparatively inexpensive and easily renewed. In order to compensate for any derangement from wear, the thrust screw *H* is made adjustable, thus providing for keeping the lever in the most desirable position at all times.

The abutting pieces *e* and *e*, on the links *G*, are to stop the jaws from moving beyond a certain limit when being brought together for engaging, or separated for disengaging the rope.



NEW GRIP FOR CARS ON BROOKLYN BRIDGE.

This grip is the invention of A. H. Mathesius, 540 Willoughby Street, Brooklyn, N.Y., the engineer who constructed the traction machinery of the Brooklyn Bridge, as illustrated in our issue of September 1st. It has just been applied on the Bridge.

Two immense dredging machines with iron hulls, intended for work on the Panama Canal, are lying in the Delaware River opposite Philadelphia. One of the machines will be sent away in a week or two, and the other will remain where it is till spring.

An inventive genius has discovered a new plan for oiling cylinders. He wants to make piston-rods hollow, so that they will act as oil pipes, and he has sufficient faith in his plan to expend patent-office fees upon it.

Notes on Repairing Boilers.

BY W. H. H.

The following notes under the above heading are of cases which have occurred under the observation of the writer, and though many of the old hands may not find anything herein recorded which is novel or interesting, I will state at the outset that it is not for their information that I am about to write. Of course, the best way, if any extensive or difficult repairs are contemplated, is to call in the professional boiler makers; but there are many minor repairs which the boiler owner or engineer can do if he has confidence in himself to undertake them. Many boilers are so remote from boiler shops as to make traveling expenses, and "overtime," and delay, very serious matters to an owner or engineer, anxious to keep his old kettles boiling as many days in the year as possible.

To such an one, who is sufficiently progressive to read the columns of this paper, it is recommended that he buy a bellows, commonly known as a *bellus*, and that he build him a forge, or smith shop, and have an assortment of hammers, chisels, caulking tools, tongs, $\frac{5}{8}''$ and $\frac{3}{4}''$ bolts from 2″ to 6″ long, bar iron, round and flat, some octagon bar tool steel for chisels, bits of boiler plate, which should be of best flange iron, $\frac{1}{4}''$, $\frac{5}{16}''$ and $\frac{3}{8}''$ thickness. A ratchet and drills should be part of his outfit; and if he has a tubular boiler, a Dudgeon tube expander will come handy some day; or in place of this, a couple of steel plugs of the diameter of the bore of the tubes toward one end, and slightly increasing their diameter toward the other end, being about 7 inches long. There should also be the heterogeneous collection of metals known as scrap, which need not be bought, but which will accumulate rapidly, the forge as a nucleus having been established.

But above all things there should be that king of all tools, a good grindstone. Tools may be ground by rolling a boulder down hill and running after it, though this is troublesome, but I have seen things called grindstones which were about as convenient. Tools may be dressed and tempered by the use of an ordinary wood fire, and sharpened previous to tempering by filing, but the process is a slow one. If charcoal or mineral coal are neither of them at hand, a very hot fire may be made with wood, assisted by the bellows.

You should have by you certain engineer's stores, such as machinery oil, not the black mixture of the residuum from the stills of the oil refineries, presented to you in those cylindrical bottles, long drawn out in the vain endeavor to make the light shine through them. You had enough of that last year, and you also look coldly upon brilliant samples of "double extra super," as you have read in these columns that these are merely mixtures of refined petroleum and cotton seed or porgy oil. You want the oil of the sperm whale, or if there be no sperm whales in your neighbourhood, then the oil of the honest hog, known to commerce as lard oil. You have hemp packing, beef tallow, white lead ground in oil, red lead dry, cast iron chips from the machine shop, rope and tackles, and tube brushes.

Thus equipped with things material, and with the knowledge about to be poured forth for your benefit, you may enter with confidence upon the care and repairs of your own boilers; how you will come out, after a year or so, I know not, but whenever you get in a tight place, and I am along your way, I will try and pull you through.

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Before letting the water out of a boiler care should be taken that the fire is all out, and the brickwork cooled down: otherwise though the boiler may or may not be injured, the mud and scale may become so hardened as to be difficult of removal. Thorough and frequent cleaning being a most important point in preserving the efficiency, and ensuring the long life of a boiler, it follows that generally any boiler which is not readily accessible for thorough cleaning once a week is not fit to be used.

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Before knocking in the man hole plates, certain precautions should be observed, for the want of which many lives have been lost. First, have the safety valve open, and be sure that the steam has ceased to flow. Second, knock in the *uppermost plate first*, and have a good chance to get out of the way of any steam which may escape. *The inhaling of one full breath of steam is certain death*, the delicate tissues of the lungs being coagulated, or partially boiled by the heat, and the victim dying as by suffocation, the lungs being unable to perform their important function when in that condition. If the lower hand holes or manholes are opened

first, the steam being lighter than the external air, is quickly forced out of the upper hole the instant it is opened, and so quickly that in many cases it is difficult to get away without being scalded.

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In certain cases care is to be used to guard against explosions of inflammable gas, which sometimes occur when a boiler has been out of use for some time, and empty, with the manholes and valves closed. In such cases the boiler should have its interior ventilated before approaching one of the holes with a light. Two instances of this sort of explosion have occurred under the notice of the writer, the inflammable gas being very likely hydrogen, evolved during the decomposition of a small amount of moisture or water upon the iron of the boiler, which, mixing with the air, produces the explosive mixture of the laboratory.

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In every case take care that the boiler is thoroughly ventilated with pure air before any one is allowed to enter. One instance I have known of a person who was overcome when within a boiler, by some sort of bad air which had passed from a sewer through the open blow valve.

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The most dangerous boilers to enter are those used at blast furnaces for smelting pig iron, where the furnace gas is used for fuel. About two per cent. of this gas when mixed with the air is sufficient to cause death, the first effect being a sleep or stupor, the victim having no power to get away when once attacked. The poisonous part of this gas is carbonic oxide, which is also the combustible part, and gives the furnace gas its value as a fuel. There are such enormous volumes of gas about a furnace when in blast that it penetrates the ground, travels long distances, and attacks its victims in most unexpected places. It not only is constantly oozing from the brick work of the boiler setting after everything is cool and repairs are being made, but there are innumerable leaks in the gas flues and valves, needing only a start of the wind to carry it into an open manhole or furnace door, where men are working.

Take no chances where the life of a man may be risked, particularly your own life; and leaving out the question of humanity, it should be remembered, that the cost in money to a community for raising and training a full grown man is from one to two thousand dollars, and if such a man is cut off in his prime there is that much loss, and in addition to this the cost of supporting those dependent upon him until they are out of trouble. In the old times, at the South, they understood this matter perfectly.

If you are going into a well you lower a candle; if the candle remains burning the air may be presumed to be good; if it is extinguished then the air will not support life and must be changed. This may be done by pouring down buckets of water, which, causing an air current, produces the required change. Or you can bring out your forge bellows and connect it roughly to a pipe or hose, and blow away. But in the case of the blast furnace boilers, a lamp will burn when the air within the boiler will cause death, and a living animal should be introduced to try its effect; a dog, for instance, costing much less than a man, might be utilized for this experiment. When the man enters, a stout rope may be attached to his heels, and he should be constantly watched from the outside by an attendant, and be promptly hauled out should he be overcome.

Thomas A. Edison, Menlo Park, N. J., has recently taken out seventeen patents for electrical appliances. Among the devices thus patented are: an electric regulator, three improvements on dynamo-electric machines, three improved appliances for electrical distribution, a method for manufacturing incandescent electric lamps, two dynamo and magnetic electric machines, a mould for carbonizing filaments and regulators for the system of electric distribution.

Address on Mechanics by Coleman Sellers, Sr.

On November 9th Professor Coleman Sellers opened the course of lectures in connection with the Franklin Institute with an address on Mechanics. We make a full abstract. The lecturer began with a review of the origin of their lecture course. During the first season the lectures were confined to men, but in the following year ladies were admitted, and this has continued to be a feature of the meetings ever since. Although the subjects treated are principally those relating to mechanics, the attendance shows that they are found interesting to ladies.

If we consider what was the state of the mechanic arts at the time the Franklin Institute was first founded, and what is the state of the same arts now, we can form a better idea of what the lecture course was in those days and what is expected of the lecturer of the present day. In business, nowadays, we measure the success of mechanical enterprise very much by the prosperity of the railroads. I think it would be fair to take the success of the railroads as the standard of the progress of the United States during the sixty years that have elapsed since the first lecture was delivered. It was in 1824 that George Stephenson began striving to induce the people of England to build the Liverpool and Manchester Railway. In 1825 he was laughed at as a visionary. You will find books in the library that refer to the bubbles talked of in 1825, and the contemplated Liverpool and Manchester Railway is referred to as the wildest of all the bubbles. At that time the term locomotive as applied to that form of engine was not invented. It was not until 1829 when that railway was opened that the term came into use. But we had locomotives before that time. In 1819 Oliver Evans took through the streets of Philadelphia an old scow which moved itself by steam. Evans foresaw the important factor that steam was destined to act in accelerating land transportation. He said, the time should come when we would start in the morning from Washington, breakfast at Baltimore, dine at Philadelphia and sup in New York, and that would be going at a speed of forty-five miles an hour, as fast as a bird flies. Even in 1825 the world was not ready for this. The proposition of traveling at fifteen miles an hour was laughed at. Trains might be run but they must be slowed down to five or six miles an hour, so as not to ruin the stage coach companies!

Great advances have been made since those days, and all other institutions have moved forward keeping pace with the railroads. To the people in Wall Street railroads merely represent certain values in money. By the people generally they were viewed from a much higher plane. To those who are assembled here in Philadelphia, the railroads are the embodiment of thought, and of more value than can be measured. We see this illustrated in the Pennsylvania Railroad we are so proud of and its fine machinery.

When the Franklin Institute was founded it was intended to carry on a school of instruction for mechanics, to impart desired instruction which could not be obtained in the public schools. The mechanic indeed must not only be a physicist in the broadest sense of the term, but there is scarcely a limit to the knowledge he must bring to his use in some way. Some one has said that a man must understand matter and apply common sense to it in order to be an engineer. The aim of our institution has been to help mechanics to understand matter and the natural laws underlying their work. In the early days of the institution, the lectures were elementary but essentially practical. They were the best that could be delivered here at the time and could not be obtained at any other place. What has been the result of this? Gradually the people have begun to recognise the need of more information than is given in the public schools. The high school of Philadelphia is the direct outgrowth of the Franklin Institute. In this and other educational institutions, it is possible for young men to obtain excellent instruction, but so far as training relating to the mechanic arts is concerned much improvement is needed. It is possible to have taught in the public schools the underlying principles of manual labor. There are a few simple tools that are used in a great many trades. Their use might be very judiciously introduced in the course of study. In our early history the workshops were not far removed from the schools. It was almost impossible to attend school from one year's end to the other. A lad had to work in the shop or on the farm for some months of the year, and he could attend school the rest of the time. What was the result of this? Its tendency was to produce good solid men who were daily applying their school instruction to workshop manipulation. Who were made by this kind of training? The men who have taken the lead in building up our system of railroads, our workshops and our factories.

What is the result of the later system of training in the public schools? The students are separated entirely from manual labor, and their heads only are developed, and this development fitting them only for the professions of doctors, lawyers, and what not. And not one single thing has come to them that will help them to enter a workshop. There is a very simple reason for this. The teachers are not mechanics. They are not expected to be. The scholars can more easily learn the things that relate to buying and selling than what relates to mechanic arts. The instruction given in the schools must bear the teacher's idea. Very few teachers in public schools are expected to understand the principles of mechanics. The examples prepared for the scholars are not taught as having relation to mechanical work. Yet many of the calculations apply as correctly to the operations of machinery as they do to the business of buying and selling. If mechanical operations were taught in schools, it would give a rest to head labor, and the hand labor would make the brain stronger.

Mr. Sellers then reviewed at considerable length the lectures of the course and their objects. In doing this he paid a high compliment to the mechanical attainments of Joshua Rose. All the coming lectures were highly commended.

Returning to the subject of mechanics, Mr. Sellers said there was a time when the two-foot rule and a few simple tools readily answered all mechanical purposes for measurement. There was a saying in Germany that every hair in a carpenter's head is one-eighth of an inch diameter. There was a meaning in that. As a carpenter does not measure so fine as a machinist does, his measuring to a hair's breadth was measuring within one-eighth of an inch. That style of measurement led to the expressions "overfull" and a "little scant," which indicated measurements sufficiently close for practical purposes. A change in this respect has come over all mechanical industries. Now the parts of machines are made interchangeable, and accuracy of dimensions must be obtained. One branch of business may need only coarse measurements, while another part may require the most minute measurements and accuracy. A two-foot rule may answer for many purposes and be very convenient, but there are measurements in the works which require the use of this convenient little device, which measures to one-thousandth of an inch. (Here he showed a Brown & Sharpe micrometer caliper. He also exhibited a French micrometer gauge, finely graduated. This he used to measure fine metallic cubes that had been finished by tool work alone, and were surprisingly accurate.) These instruments, continued Mr. Sellers, are remarkably fine; but Mr. Bond, who will lecture during the course, is connected with a shop (Pratt & Whitney's) that makes gauges of various kinds, and there they have perfected a machine which records more closely the actual size of materials than anything ever made before.

Everything in nature obeys certain fundamental laws, and all mechanical movements are regulated by these laws. There are certain principles of movement called mechanical powers, as the lever, the wedge, the screw, the pulley, that are used in various forms through all machines. The building of a complex machine seems very much like the forming of a complex sentence. Letters combined form words, words combined form sentences, and sentences make books. In the locomotives that pull trains from ocean to ocean, we have combined all the mechanical elements, wheels, pulleys, levers and screws. We have beautiful sentences in mechanics as well as in books. One maker produces better arrangements in his machines than others, and so he makes a more harmonious machine than his neighbors. In the same way one author combines his sentences better than another.

After reading some sentences in Ball's work on mechanics, a book which he cordially commended, Mr. Sellers proceeded by the aid of models and diagrams to elucidate the principles of virtual velocities. In a clear and interesting manner he demonstrated the relations that exist between speed and power in the application of the various forms of levers to machinery.

In computing the power of machines, he continued, friction must be well considered or mistakes will be made. A considerable proportion of the power of machines is absorbed by friction, but friction is valuable to the mechanic for all that. But for friction a locomotive could not pull a train, because the wheels would slip round without moving ahead. In fact, at first they thought that friction between the plain wheel and rail would not suffice to make a locomotive pull a train, and they proposed to lay down a rack rail for a cog wheel on the engine axle to work in. This was one of the first obstacles to the success of the locomotive; but they soon found that a rack rail was not needed. Another example of friction is rather striking. The transmission of power from the steam engine to the various parts of a machine shop is usually effected by a line of shafting. Now in quite a large machine shop when the belts are thrown off one man can take hold of the rim of the main pulley and turn all the shafting. Let us see what work the man is doing in relation to what the engine has to do in turning the shaft. The man employs his weight of 150 pounds to the outside of the wheel, and he would have to turn it 120 feet a minute to keep it at the speed the engine has to maintain. Thus you have between 12 and 13 horse power consumed in running the shafts of that shop. The man does not exercise one horse power, though he may have a cold and be a little *hoarse*. A horse power is 33,000 pounds raised one foot in one minute. One pound raised 33,000 feet in one minute would be the same power exerted. On this basis all engine work is measured.

By means of a Weston differential pulley block and chain, and also the Harrington hoist apparatus, which has pulleys operated by a worm screw, Mr. Sellers showed the principle of applying power in that way. He also demonstrated the loss of power by friction in the two kinds of apparatus and in a train of wheels. The amount of pull required to operate the chains was ascertained by means of a spring balance. The different apparatus showed a striking difference of loss due to friction of the working parts, but in the best performance the loss was considerable.

Now, said Mr. Sellers, it is the want of this kind of knowledge that should be met by the public schools. That is felt in the community in the ready acceptance of things that are impracticable. It is not a new thing for persons to think that perpetual motion is possible; and it is not a new thing for people to say they have discovered perpetual motion when they know they have not. There are many cranks besides the crank that turns the grindstone, but the worst crank is the crank who is going to improve on the crank. Perpetual motion is a wrong idea. When people become pretty well acquainted with the principles of mechanics and with the laws of the universe, they can be shown that perpetal motion is impossible. Those who understand the laws relating to the con-

servation of energy know that no power can be obtained without the dissipation of energy. Falling water may keep a mill wheel going continually till the parts wear out, but the water has been raised above the wheel by the sun's rays. That is no perpetual motion; it is power begotten of heat. Heat may be applied to water to tear the atoms asunder till they exist in the form of steam which is capable of doing work; the atoms of water may be still further heated till they are separated into their elementary gases, but the work to be got from them in either case will be less than the heat energy expended. When we burn coal in the furnace of a boiler, it is converted into heat, and heat boils the water, and the water converted into steam drives the machinery, and we call it very justly the steam engine. The steam engine does not use all of the heat by any means; probably not more than 12 per cent. of the heat coming from the coal is utilized in our best engines. What a long distance between the actual practice and what we may hope to obtain some day in the perfection of mechanism!

More than seventy years ago a great furore was created in this country by a citizen of this State named Readheifer who claimed to have invented a machine that would run without expenditure of power. He pretended that were the weight *W*, Fig. 1, held stationary on the inclined plane it would exert force to move the car. If again the car were held stationary it would exert a continued force upon the obstacle that prevented it from moving. He mounted four of these cars upon a disc with teeth round its circumference, which connected with a smaller wheel similarly constructed. Both the wheels rested on arbors turned down to a fine point. He started this machine and it seemed to go all right. The pretented discovery was puffed in all directions, just as similar schemes, some of them not a hundred miles from Philadelphia, are advertised to-day and a great many people believed in Readheifer's machine. The legislature of Pennsylvania appointed a commission to examine the machine, and Mr. Sellers' grandfather was one of the commission. Like other pretended discoverers of marvels, Readheifer would not permit the commission to take the machine apart. This made a rigid examination difficult, but Mr. Sellers being a mechanic, looked closely to the operation of the two wheels, and he discovered that the small wheel was driving the large one instead of receiving the power from it. This led to the dlscovery that the motive power was clock work placed in the base of the machine and applied in an ingenious way to the arbor of the small wheel.

This perpetual motion humbug appears under various disguises. Some time ago a great stir was caused in England by the alleged discovery of a new power called psychic force. A scientific gentleman in Philadelphia got deceived by this pretended force, and the performance of a spiritualist which he had witnessed confirmed his belief. This gentleman often talked with Mr. Sellers on the subject of this new force, and nothing seemed able to convince him of its fallacy. One evening he called at Mr. Sellers' home, and when they were conversing, another scientific friend came in. The subject of the new force was again discussed, and Mr. Sellers volunteered to show some of its manifestations. He took a round ball which he had previously prepared by putting holes through it in the form shown in Fig. 2. Now, he said, here is a round ball with a straight hole through it, and he pushed a pencil through the hole to prove it straight. Then he pushed a small rope through the ball, and stretching the rope between his hands he put it in a vertical position and made the ball descend, fast or slow, just as he wished. The credulous scientist at once concluded that Mr. Sellers was exerting mind influence over the ball, but the other set his inventive faculties to find out the trick. He guessed that the hole was not straight through the ball, and that Mr. Sellers controlled the speed of the ball by tightening the rope. This was the truth. Instead of pushing the

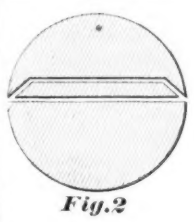


Fig. 2

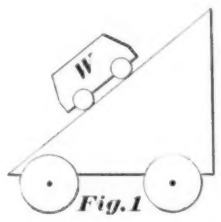
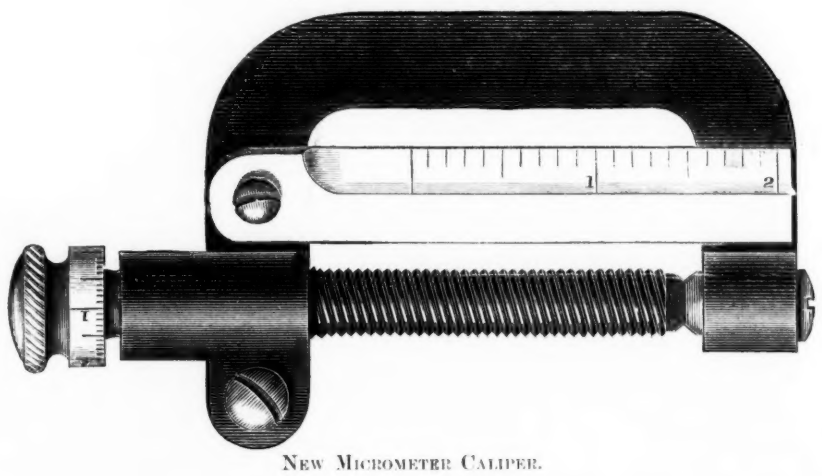


Fig. 1

rope through the straight hole which was there for deception, he worked it through the crooked hole, and by that means was able to control the ball. Here were two men, both of them scientific gentlemen; one of them investigated the phenomenon, and the other believed what he saw.

In the consideration of everything that is going on in the world, in investigating matters connected with these elementary powers and other mechanical questions, you cannot be too well grounded in the laws of mechanics. That will give you ability to understand the kinds of appliances that can be utilized in your work, and will guard you against deceptions.



NEW MICROMETER CALIPER.

New Micrometer Caliper.

The engraving represents, full size, a new micrometer caliper or gauge, from Frasse & Co., 62 Chatham street, New York. This instrument is made to measure from 0 up to 2″. The screw is 20 threads to the inch, and the number of divisions on the disc is 50; hence each division of the disc represents a movement of the contact end of the screw of $\frac{1}{1000}$ of an inch. The scale is shown folded up. In use it is swung around on the hinge screw till the graduated edge is in contact with the disc. The graduations on the scale are in tenths, so that an inch and tenths of an inch are read on the scale, and the finer division on the disc, without the necessity of any calculations. The scale readings are made with the zero mark on the disc against the edge of the scale, so that by keeping the screw adjustment (by means of the fixed screwed point) so that the zero mark corresponds with the edge of the scale when the gauge points are in contact any slight error, should there be one, in the longitudinal position of the scale or in the scale graduations will not affect the accuracy of measurement.

From the Denver *Journal of Commerce* we learn that the mammoth steel works in Colorado are searching for new industrial worlds to conquer, and that they have already turned their forces against the ordinary wooden railroad car. This they intend to vanquish, and supply cars of steel. They say the expense of their construction will be but a trifle more than those composed of wood. Good timber is constantly becoming more expensive, while the best of American steel is annually becoming cheaper. Our machinists are constantly introducing new and improved machinery to cut, carve, bend, mould and form steel for any and every legitimate purpose. A little competition among the architectural geniuses who furnish models for cars and coaches would soon furnish the safest, most beautiful and enduring coaches yet placed upon a railway track. Better still, such cars would run for an age, while in use they would cost less for fuel, light and repairs than wooden ones; and better than all, they would inspire travelers with a confidence of immunity from danger that now hovers over every considerate person who pillows his head within a richly gilded combustible sleeper.

The Milling Machine—Its Construction and Uses.

By JOHN J. GRANT.

TENTH PAPER.

In leaving the plain milling machine and its tools and fixtures, and taking up other styles and descriptions of this class of tool, the reader will not for a moment think that all its merits, or all the varieties of work that can be done on this valuable machine, have been discussed in these few papers. Its range and capabilities are very large, and can only be found out when a machine is purchased and a competent man secured to make tools and fixtures suitable for doing the kind of work required in the shop. Before leaving the plain milling machine the writer would say, that since these papers were begun he has had made and put into use four gangs of cutters, with suitable fixtures, for milling on all sides the aprons of a 14″ engine lathe. Fifty of these aprons were milled with no perceptible wear on the finishing cutters, and very little on the roughing cutters, and at a cost of less than one-third that of planing the same number made in a previous lot. Less labor was required to finish them when milled than when planed, and they were nearer to gauge than those planed, and therefore required less fitting when the feed gearing was being assembled.

The family of milling machines is large, and embraces the following well known varieties as well as numberless special machines: universal, profiling, gear cutting, both spur bevel and rack, hand milling machines for light, difficult cuts, and screw milling machines in which the operation of cutting is reversed, the cutter standing still and the work revolving.

The universal machine is very well known in most well-equipped shops, although the writer has been in shops within the last year that are fairly stocked with good modern tools, into which the milling machine, either universal or plain, has not yet found its way. There are several good universal milling machines on the market. Standing at the head as pioneer in this style of machine is the Brown & Sharpe, and as examples, machines of this class by E. E. Garvin & Co., the Brainard Milling Machine Co., and C. E. Lipe. All of these machines have good points, and some enterprising firm will one day probably combine them all and bring out a universal milling machine that will embody all their good qualities and none of the bad ones. Until then we will *struggle* along with what we have, and hope for the better machine.

The name "universal" is given to this class of machines on account of the almost endless variety of work that can be done on them. To describe one-half the operations that can be accomplished would fill volumes. But with the attachments generally sent out with the machine, work of the following character can be done, besides numberless other operations: Plain milling of various kinds; making milling cutters, both straight and spiral; grooving taps and twist drills; gear cutting of small dimensions, spur bevel, spiral, and worm gears; drilling index plates, or holes in fixtures, or jigs that require accurate distances either circular or straight; milling pieces for handles, either square or hexagonal; squaring or slotting screw heads and other similar work. A great many operations in die sinking can be done on this style of machine to advantage. A large assortment of cutters and arbors are essential to the profitable working of a universal milling machine; but the odd cuts that can be taken, that in hand work would require hours to do, can often be done in as many minutes. A full set of collets, with various sizes of shank cutters, such as were described in a previous paper, together with an assortment of bevel cutters for cutting mills, are essential to make a beginning. The bevel cutters can be bought, as they are kept in stock by the makers of the universal milling machine. A swivel vise with graduated base is a very handy tool, and should be included in the outfit. A tool-post fitted to the platen in connection with a universal chuck fitted to the spindle, makes a nice arrangement for cutting off small sizes of stock for tools. When the machine is in a tool room having only one lathe such fixtures will often save valuable time, as the lathe can be kept at work turning while the stock is being cut. In fact I have never seen a universal milling machine in a shop employing a dozen men that could not be kept at work profitably all the time. With experience and no instruction a good workman will find ways of doing the most intricate jobs that are always coming up in a machine shop, and can do them in so short a time that it will astonish him.

In the next paper I will show the manner of doing work on this machine, commencing with the making of cutters as this is one of the important jobs done on the universal machine. Manufacturers having anything new in the line of milling machine fixtures or appliances for such work may help these articles by having them illustrated and described, as anything done to help to introduce the milling machine is surely missionary work for the machine shop.

The *Locomotive*, published by the Hartford Boiler Insurance Company, says: "Steam pipes, whether used to convey steam for heating or power purposes should always pitch downward from the boiler, so that the steam and water shall flow in the same direction. When pipes are arranged to drip back toward the boiler, there is always trouble, unless the pipes are very short or very large. Vertical pipes or risers must, of course, drip in this manner, but when they rise from the end of a horizontal section of pipe they should always have a relief or drip-pipe at their lower end. This relief should connect with the main return, if it is a gravity-heating system, below the water line. If it is any other system, the drip may be discharged by means of a trap, or through a valve, or any suitable arrangement.

"When pipes are reduced in size, a drip or relief pipe should always be put in, or the larger pipe will fill with water up to the level of the lower side of the smaller pipe. The same remarks apply here as in the above case.

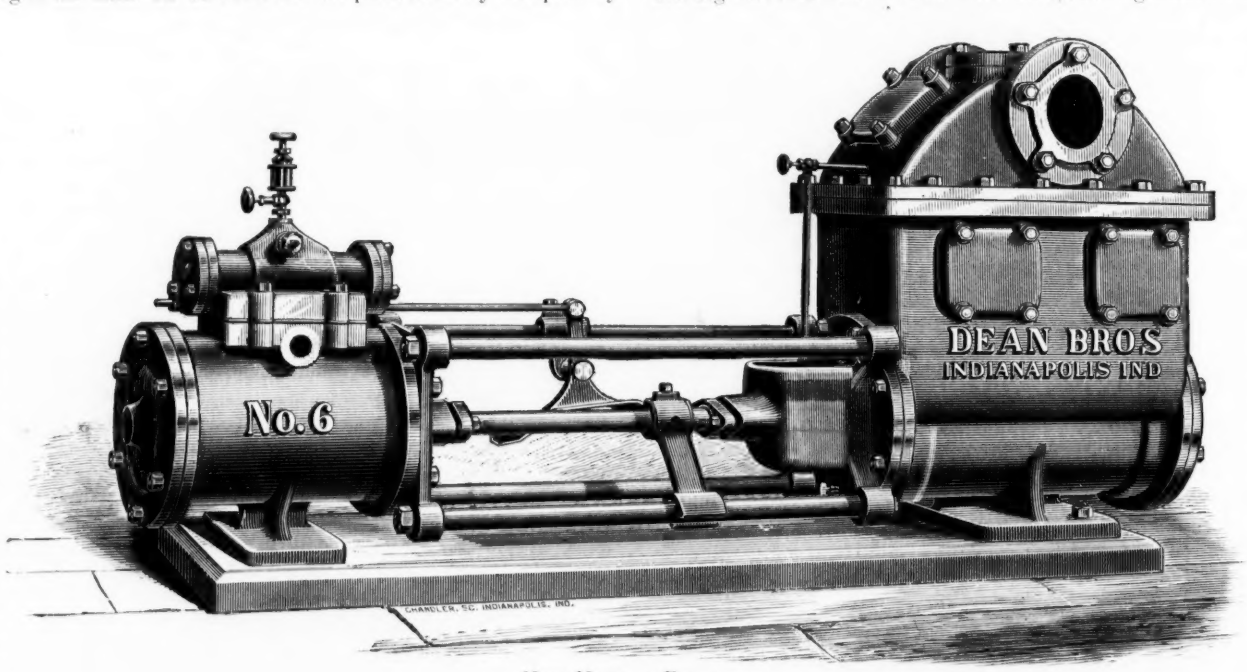
"Common globe-valves should be put into pipes with their stems or spindles nearly horizontal, otherwise the pipe will be trapped half-full of water, which will cause hammering. Open-way valves may have their spindles vertical."

In ancient times Diogenes wandered around with a lantern looking for an honest man, but didn't find one; and in these degenerate days the gasman wanders around with a lantern looking for an honest gas meter with pretty much the same success.—*Merchant Traveler.*

New Vacuum Pump.

The double-acting vacuum pump, herewith illustrated is for use in refining cane or grape sugar, for distillery "cookers," or for any purpose where a vacuum process is necessary. It is designed to maintain a high and even vacuum, either wet or dry, and to work equally well under all circumstances. It occupies but little room, and is complete and self-contained.

The valve seats, valve stems, lining, and piston-rod are all of brass. The stuffing-box is sealed by a reservoir of water, so that no air can enter. This pump is also used as an air-pump for condensing engines, working efficiently on either surface or jet condensers. It is made in a variety of sizes, by the Dean Brothers' Steam Pump Works, Indianapolis, Ind.



New Vacuum Pump.

Personal Recollections.

By S. W. Goodyear.

CONNECTING RODS.

In a previous article under this title I referred to some experience in sewing machine construction. Among other pieces which entered into the make-up of these machines were two connecting rods of malleable iron, the ends being of spherical shape. These had been finished by turning in the lathe on centers, after which the holes for the studs—by which they were connected with the cranks and needle bar respectively—were located by laying out, and were drilled and counterbored while held in a forked rest attached to a face plate on the dead spindle of a small drill lathe. That these connections, so called, should have been unlike each other in length, and size, and shape, and distance between holes, and that the holes were often not parallel with each other in any direction, was not strange, if judged by subsequent experience. But with nothing to depend upon but the skill of the operator, there was nothing for the assembler and adjuster to do but to twist the connections to bring the holes parallel one way, and bend them for the other way. And by bending, and twisting, and reaming out holes, which were already large enough, if only in alignment, the machines were finally got so that they would run; but many times with a catch and let go motion characteristic of lack of proper alignment, which was expected to be cured by the "wear to it" treatment.

Who believes that as long as these connections were made in the manner described there could be uniformity such as is now considered not simply desirable, but necessary in the manufacture of sewing machines and thousands of other machines, and articles of manufacture? The superintendent and foreman might command, entreat, beseech, scold, coax, discharge old hands and employ new ones; the assemblers might come twenty times a day to show that the work was wrong, that it would not come together, that what went easy part way around would cramp so badly before a full revolution was made that it would not go at all. It all did no good. Was it lack of skill? No; it was lack of a suitable method. Nothing is so discouraging to the old-time skilled workman as this multiplication of pieces practically exactly alike, unless he is willing to adopt the new methods. Nothing else tests the accuracy of work so rigidly as the demand for interchangeability. By the old-time skill, when but one piece was to fit a certain hole, and that hole was called one inch, it mattered little whether the hole was exactly one inch, or whether it was $\frac{1}{64}$" above or below the nominal size. Within $\frac{1}{64}$" was close measuring if an actual size was concerned, as taken from a rule. By the modern methods, to make 1,000 or 10,000 pieces so nearly alike that no selection needs to be made, but all will fit the size of hole for which they were made practically alike, and to make the problem apparently more difficult, 1,000 or 10,000 holes so alike as to be promiscuously interchangeable, and the size to be, if called one inch, so near the exact size that .00025" (one-sixtieth part of the variation admissible when measured in the old way) variation would be cause for complaint, is part of the everyday practice in thousands of shops.

But as it is probable that a statement of facts will be more interesting than mere expression of opinion, let us examine the method which was adopted for the production of connections practically free from the objections attending the almost entire lack of method by which they had been made.

HOLLOW MILLS.

By the use of a hollow mill of suitable shape, with a hollow center in the dead spindle of the lathe in which the hollow mill revolved, longitudinal motion being given to the dead spindle by a hand lever, and the forward motion of the spindle restricted to any point required by an adjustable collar on the extension of the spindle, which had been screwed into the place formerly occupied by the tail screw, this collar bringing up against the back end of the tail stock, it became an easy matter, after straightening, to mill the ends of any number of these castings to a half circle, and with the extreme length from apex to apex of the semicircular ends alike. Now, with hollow centers in both spindles of an engine lathe, and a tool representing such part of a circle as would begin cutting where the cutting of the hollow mill ceased, the cutting was carried down on the opposite side of the partial sphere until the neck of the rod was just trued up concentric with the spherical ends. When the tool had been carried forward just enough for its cutting to match with that of the hollow mill, with the forward motion of the tool restricted to just the right point by a rigid stop, and all possible lateral motion—when once placed in the right position—provided against by clamping the carriage in position, is any argument needed to convince the reader that without centering, in a fraction of the time taken by the old method, work was produced which was practically uniform in shape and size?

DRILLING AND COUNTERBORING.

Next came the drilling, which was accomplished by clamping the connection in a box-jig and drilling both holes before it was removed. In this way uniformity of distance between holes was insured, and as both holes were drilled from the same bearing surface, with the jig properly made and properly used, the holes were necessarily parallel with each other. After the drilling came the counterboring for the head of the studs, after which the burrs left by drilling and counterboring were removed with a counterbore, and the oil removed by immersing in hot soda water, and the work was turned over to the polishers.

POLISHING AND PLATING.

On wood wheels covered with leather, and coated with emery of suitable size—for the "tanite," and "diamond," and "stone center," and a thousand and one other solid emery wheels had not then come to be used to any extent—the rod part of the connection was ground down to match the turning. After this came polishing, and fine polishing, and glazing, in which the mysteries of the polisher's trade were brought to bear in the shape of hot water, and soaking, and scraping. Glue, and No. 90 or 100 emery, were followed by flour of emery and tallow and beeswax, and bits of charcoal, and divers pieces of white flint stone, and hickory stick, by the aid of which a coating of emery cake was made to adhere evenly to the surface of the wheel already coated with glue and fine emery, and in an incredibly short space of time the connections were ready to be silver-plated. Here in the polishing department is to be found real skill—skill which cannot be gainsaid or gone back of by labor-saving machinery.

MAKING HOLLOW MILLS.

Having said that hollow mills were used, it is possible that some readers may wish me to tell how they were made, for as made sometimes they are difficult to make, and of little value when completed. Among my force of tool-makers was a man much my senior, who had spent a great part of his life in gun making, and in making tools to be used in the manufacture of guns. He said, after seeing the first solid hollow mill only partially successful, "I can make a tool for that work that will beat anything you ever saw." He got the job; and after about a week spent in turning and planing, chipping and filing, and cutting and trying, he produced a tool consisting of a stem fitting in the line spindle of a lathe, with a projecting end of quadrangular form, the thickness of which was about one half of its width. Across each side of this, at some distance back from the end, had been cut a shallow groove; this constituted the shank, to which the cutter proper was attached. This consisted of four square pieces of steel, of such size that when laid together in the form of a square they would together measure the same as the projecting stem measured in width. These four pieces of steel being of such length as would reach back to the back side of the above mentioned grooves, and project beyond the projecting end of the stem sufficiently for the cutting part to be properly supported, were halved down from a point corresponding with the end of the stem when the back end of the pieces were even with the back side of the transverse grooves in the stem—except that a projecting rib was left at the back end, which accurately fitted the grooves. In this way the four square pieces were, by the aid of a square band, driven upon them when placed in position on the stem, firmly locked there, with their four meeting corners at the center, concentric with the axis of the shank. Then by turning or reaming a cavity of the shape and size to which the hollow mill was designed to cut, removing the square clamping band and filing away a section from each cutter to produce a cutting edge; with a graver relieving the cutting edge on each piece, hardening and tempering the cutters, and replacing with the band firmly driven on to hold them in position, a tool was had, which judging it by the way it worked, my veteran tool-maker had a right to be—as he was—proud of. *But how it had cost!*

Here was an abundance of old time *skill* displayed in making this tool, and the tool was all right, but to be able to use such tools economically there must be a *method* adopted for making them. Had the tool been patented, the method which I adopted for making a tool which differed widely from it, but still "worked just the same" might have been called "getting around the patent." If my improvement had been patented (which it was not) the patent would have expired before this time, and as the company for whom the invention (?) was made have had the use of it all these years on other than sewing machine work, "I will give it away."

Thousands of the tools have been made, and still I have never seen them used away from where they originated.

HOW IT IS MADE.

Fit a steel stem into the spindle of the lathe head in which the cutter is to be used. Let there be projecting beyond the end of the lathe spindle a couple of inches of this stem, more or less. Cut a thread for from $\frac{1}{2}$" to 1" at the end of this projecting part while in the spindle where it is to run. Fit a nut—preferably round, with two sides flattened for the wrench—snugly to this threaded portion, letting the boring for threading in the nut stop short of reaching through the nut by from $\frac{1}{16}$" to $\frac{1}{4}$," depending upon size of work. Let the bottom of the hole in the nut, for tapping, be flat. With the end of the stem squared up perfectly, and the nut screwed on, proceed to put a hole through the front of the nut and into the end of the stem, of such size as will leave the threaded portion sufficiently strong, the depth of this hole again depending upon the size of work to be done. Let this hole have a flat bottom. This is the chuck in which the cutters are to be run. A set of cutters constituting a hollow mill, or squaring up cutter, or counterbore which can be taken apart for sharpening or repairs at pleasure, and adapted to use in the above described chuck, may be made by taking four square pieces of steel of suitable size and length, and placing them in a chuck especially designed for the purpose, turning them down round to a point something beyond half their length, and next turning down less than half the length to a size exactly fitting the socket in the chuck. Now placing the turned end in another chuck especially designed for this use, turn the second end the same as the first was turned, and a double-ended reversible set of cutter blanks will be had with a collar in the center of double the thickness which the smaller turned part at each end fell short of reaching the center of the length of the pieces. This thickness of collar, as also its diameter, compared with the part which fits the socket in the chuck, and the opening at the front of the nut, is entirely optional, or may be governed by what experience teaches is necessary if the judgment fails to hit the proper proportion.

It will be obvious to the reader that these cutters must run true in the chuck described. That with the collar on the cutter nicely squared up and gripped between the end of the chuck and the flat-bottomed bearing in the nut there will be little danger from turning in the chuck, is easy to believe without trying. With the special chucks in which to turn these cutters once made, the cutters themselves may be made very cheaply. For many shapes of work, and where many cutters are to be made alike, the relief may be put on by the use of a milling cutter of suitable shape, and the cutting away the stock to give clearance and a shearing edge may be done in the same way. The great advantage to be derived from the use of these cutters is in the facility with which they may be taken apart (after drilling and reaming or turning to shape) for the milling or filing to an edge, and for clearance and relief, or at any time for sharpening, or working over. I have built many machines, in which (the sole use being to do the kind of milling referred to,) the spindle itself was made to represent the chuck, the nut taking the same place as the face-plate on a lathe spindle, and the cutter the place of the lathe center. I have also used the same method for securing punches in the spindle or shank in which they were used. For punching small holes and driving rivets from solid dies after heading, or for the punch against which rivets are headed, and for sundry and divers other uses, many people are in the habit of making the punch proper a solid part of a great heavy shank, the shank part containing ten times or twenty times as much steel as is contained in the real punches. Then this shank is turned up tapering to fit a socket, and the punch part is turned to size, and when the punch proper breaks, the whole thing goes into the scrap. Shops are to be found where the business of whole rows of lathes, with their respective lathesmen, is to turn up these punches. Tons upon tons of steel, worth from fifteen to twenty cents per pound, are speedily converted into scrap worth but a fraction of a cent per pound, while the labor laid out amounts to several times the original cost of the steel. By making sockets the same as described for the cutters, except that no hole need be drilled into the end of the stem, and making the nut sufficiently long to afford a support, insuring a concentric position of the punch, with a nut for each different size of punch, the hole through the nut fitting the punch snugly, and being slightly countersunk at the inner end, the punches proper may be turned up with slight heads fitting this countersink by which they can be drawn firmly against the end of the spindle by screwing up the nut. Or pieces of drill rod may be used for punches, by upsetting the end, and all turning avoided, as all needed sizes of the drill rods may be had from $\frac{5}{8}$" or $\frac{3}{4}$" diameter down. I am aware that the equivalent of this method is used by many parties, who cut up drill rods to suitable lengths, and harden them ready for use by the hundred or thousand; but while so many are sticking to the old way in spite of continued improvements all about them, will not this, my "mite," cast in among the multitude of good things, do some one good?

Double Circular Sawing Machine.

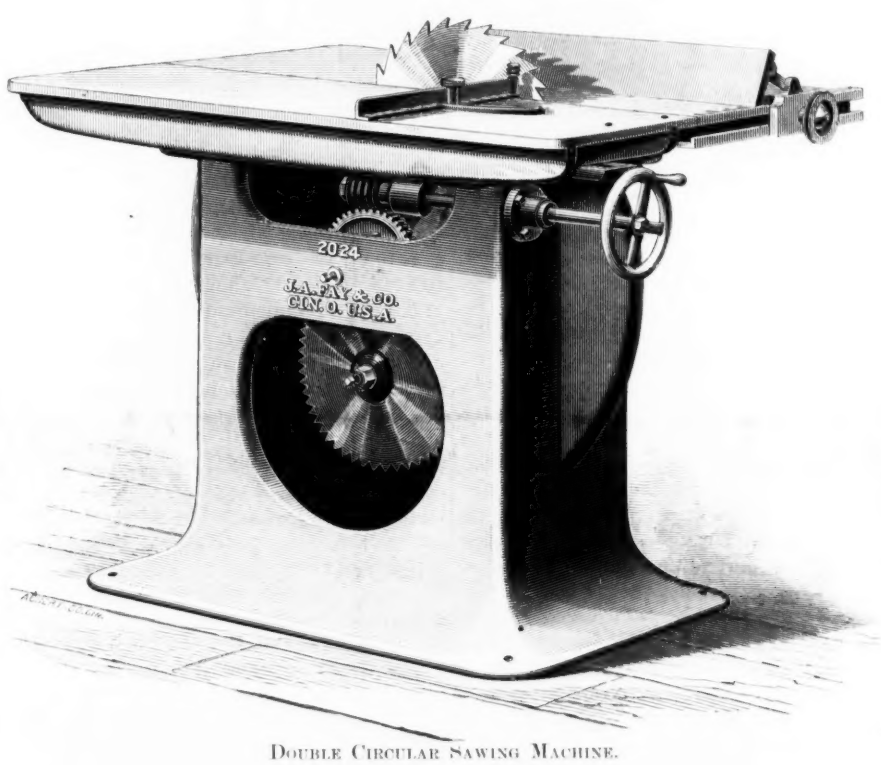
The engraving presented with this represents a machine recently brought out by J. A. Fay & Co., Cincinnati, O. Two saws are used with this machine, one for ripping and the other for cross-cutting, both of which are driven by one belt, the arrangement being such that when one of the saws is in position to work the other one is at rest. Either saw is brought into position to cut by turning the hand-wheel shown, the same operation moving the other saw out of the way. The saws can be adjusted at any desired height, within their capacity, above the table, so that grooves of a definite depth may be cut.

The table is in two sections, the right-hand section being stationary, and used in connection with the ripping saw. The fence or guard on the main table can be quickly adjusted to any position from the saw, and can be inclined to any angle up to 45°, and instantly brought back to a right angle. This gauge is removable, to provide for cutting off long stock.

The cross-cutting table slides upon V ways, and carries a cross-rest, which can be set to any angle by graduations on the table.

This machine, as will be seen, has a wide application for all kinds of moderately-light wood work, where accuracy and quick working are essential. It is furnished complete, with countershaft, wrenches, &c.

Reports having reached this office that the Joy valve motion placed on an engine belonging to the Philadelphia & Reading Railroad had not proved a success, a representative of the AMERICAN MACHINIST recently called upon Mr. Richards, the master mechanic who has charge of the engine, to find out the truth of the matter. From this gentleman we learn that the motion has worked very well, is still in service, and gives entire satisfaction.



DOUBLE CIRCULAR SAWING MACHINE.

LETTERS FROM PRACTICAL MEN.

Proposed Plan for Making a Correct Index Plate.

Editor American Machinist:

I wish to suggest there is yet one untried plan for making a correct index plate; that is, by electroplating. Take, for instance, a plate made of any metal, capable of solution and deposit, face the plate truly and set in a level position. Now take a series of plugs, or small collars, made of the same material as the plate, and place them in a true circle on the plate. If the faces of these plugs or collars are ground true they will make a tight surface fit against the plate. If held in the proper position, and the whole placed in a bath, metal similar to the plate and plugs or collars may be deposited. If plugs are used they may be so treated as to be removed from the metal after the plating process is concluded, or they may be left to stand, forming the stops. If collars are used, they may be left, forming the holes. In either case, some method of holding the plugs or collars must be employed, and some means of spacing, as Professor Sweet's method of holding them in a ring, or some other. A current of electricity may be passed through the whole while spacing the plugs, or even through the plugs or collars during the whole process of manufacture. The use of the same metal for all the parts avoids errors from unequal expansion. There are other things that suggest themselves, such as making the entire piece of metal electro-deposited, &c.

WM. WALES, JR.

Boiler Explosions—Blowing Out versus Blowing Up.

Editor American Machinist:

Allow me to say a few words on the inconsistency of some boiler explosion theories recently expressed by alleged practical men of years enough experience to teach them to know better. Let us see what will make a boiler explode. It has been explained and summed up in the AMERICAN MACHINIST, in these few words, and wisely too, in my estimation: "A boiler explodes because the strain imposed upon it at the time is greater than the strength of the weakest part of the boiler to resist it." This being the case, I hold that no amount of water at the time present in the boiler will save it from destruction, and will not even mitigate the catastrophe to a comparatively harmless blowing out, instead of blowing up. I do not know that there is much choice between blowing out and blowing up, when the boiler of the steamer Riverdale is taken as a case. This boiler blew out one of its bottom sheets, and took the bottom of the boat with it. Now according to the nothing-but-low-water-can-cause-an-explosion-theory, this otherwise sound and well made boiler should have simply blown out at this particular weak spot, and harmlessly spilled its contents in the hold of the vessel, but I, and no doubt thousands of engineers who saw the boiler after it had exploded, have come to the conclusion that not only was low water entirely out of the question in this case, but that a weak spot in the shell did cause the accident, and I don't think there was any more pressure in the boiler at the time than the law allowed.

To return to our text, if a boiler will explode from a weak spot (sufficiently large) in any part of its structure, the next question is, what will cause such a spot? I say there are several causes which may lead to it, and a very important, but by no means the only one, is low water, which permits certain parts of a boiler, exposed to the action of the fire, to be burned, and hence weakened; and if at this time water is pumped upon the hot sheets, and the strain of sudden contraction is added to that of the steam pressure already upon it, then the probability is there will be a giving away of this weakened spot, and the result (owing to the now suddenly changed condition of pressure and temperature in the water) will be a sudden expansion of the water and a consequent enlargement of the fracture, even through sound sheets, and the whole can be summed up as a boiler explosion.

Again, the same thing may happen in a boiler with corroded sheets, as in the Riverdale boiler, or from other parts becoming weak from natural wear after years of use. All this goes to show that a boiler can and will explode regardless of the amount of water it may contain, if the boiler, or the weakest part, is not strong enough to resist the pressure. Under these circumstances, the more water it contains, the greater the destruction.

Now, Mr. Editor, I do not believe there is any mystery about steam boiler explosions, and I do not take any stock whatever in the mysterious gas and sudden-generation-of-incalculable-pressure-theory, because as nothing begets nothing, I cannot see where the enormous alleged force could come from. It is well known that all force in a steam boiler must be transmitted to it from the coal put into the furnace, and although the crown sheet be heated red-hot and water thrown upon it, so far as the generation of pressure is concerned, from that source it would amount to nothing, as there could not be enough heat stored in it to make more than a respectable *sizz*. But it could and would probably give way under the combined force of the normal pressure then in the boiler, and the destructive action of the water on the hot sheet. I have never been an eye witness to a boiler explosion, and like your correspondent McConnell do not hanker after that kind of practical and ocular demonstration. But I have made it my business whenever I could to view the remains, so to speak, of exploded boilers, and have long since come to the conclusion that boilers can and do explode from the fact that certain parts at the time are not strong enough to stand the pressure, and altogether regardless of the state of the water.

P. H. G.

"The Standard Gear Tooth."

Editor American Machinist:

In your issue of September 15, Geo. B. Grant advocates the adoption of a standard gear tooth, viz.: the involute. At the conclusion of his article, Mr. Grant invites "believers in the old circular pitch, the epicycloid tooth, &c., to stand up and give their reasons."

I think it is the experience of most men that the more they have studied on the subject of toothed gearing, the more clearly it has appeared to them that they would never be able to firmly believe anything in regard to it. The *dentistry* of gearing is a subject upon which a great deal of attention has been bestowed by some of the best mathematicians and mechanics, and still, like most every other subject, it is supposed that there is yet more to be learned about it. Some facts, however, have become pretty well established in regard to the comparative merits of the involute and the epicycloidal forms.

I believe the peculiar merits claimed for the involute are: that it is very simple; that the cutters for forming the teeth may be made cheaply; that the velocity ratio is not affected if the pitch circles do not happen to exactly coincide, the teeth engaging correctly as long as they engage at all, so that greater inaccuracies are admissible in the construction of machinery upon which such gears are used.

Some of the advantages claimed for the epicycloidal forms of tooth, are: that it causes less thrust on the bearings, and consequently less friction, not only on the bearings, but upon the teeth themselves.

And by varying the size of the generating circle, a form of tooth can be employed which is best adapted to the work in hand; and they certainly look much better, especially on large gearing, than involute teeth. The size of the wheels can be computed by diametrical pitch, regardless of the shape of the teeth; so that the involute system, has of necessity no advantage in that respect.

By a comparison in the advantages of the one system over the other, it would seem that the involute form is best suited for use by machinists whose facilities for gear-cutting are not very perfect, and who do not want to be troubled with too much arithmetic. It is perhaps the best form for use

on all that class of machinery which is usually, and often necessarily, built without much regard to exactness of distance between centers; and is probably the best in the case of the change gears of lathes and universal milling machines, the distances between centers of which are regulated by Tom, Dick, or Harry, and are probably not set just right more than once in a thousand times, but in which it is very important that the velocity ratio should be constant. But now comes the fact that there are machine builders who are willing to go to almost any amount of trouble and expense to secure that gearing which is the best, and believing that by the use of epicycloidal gearing they can secure much the best results, does any one suppose that they will consider themselves bound to forego that advantage, and confine themselves to the involute form of tooth, simply because there are other people building a different quality or class of machinery, whose work does not require fine gearing, and who of course would not see the necessity of using it.

Suppose, for instance, that a man wants to construct a machine for a certain purpose, the gearing of which will be required to transmit but very little power, but where it is especially important that friction shall be as nearly eliminated as is possible. Now I think, that if this man thoroughly understands his business, he will design his machine with special reference to the objects in view, and will use the epicycloidal form of tooth, the curves of which he will generate by the use of a rolling circle larger than the pitch radius of the wheels, thereby securing a form of tooth something like Fig. 1. This tooth is not beautiful, nor strong, but it will cause very little friction. Again, if he wished to construct another machine, the gearing of which would be required to transmit great power, he would probably use for the generating circle a diameter smaller than the pitch radius of the wheels, thereby producing a tooth something like Fig. 2, which is not so nearly frictionless, but is much stronger than Fig. 1. In this case the attainment of the best possible results would not be consistent with uniformity and interchangeability. If he were bound by a universal rule, as Mr. Grant suggests, the teeth in both these machines would be like that shown in Fig. 3; and in neither case would it be the best possible form by any means. Any way two gear wheels may differ from one another in other respects besides the shape of the teeth; they may differ in pitch, in thickness, in the length of the hub (if there is one), in the size of the bore, or one may be webbed and the other have arms, and any of these things are liable to interfere with interchangeability. The fact is that uniformity and interchangeability are all right, and very desirable, and practicable to a certain extent; but like many other things, they may be carried too far. If carried to the extent some have advocated, in your columns and elsewhere, our machinery would be all about alike, no matter by whom built, or for what purpose; and all individuality in machine design would be crushed out. This I think is not desirable or possible. I am inclined to think that a man who proposes to make gear wheels should be at liberty to choose that form of tooth which is best suited to his work, whether it be the involute, the double arc, or some form of the epicycloidal,

Fig. 1

Fig. 2

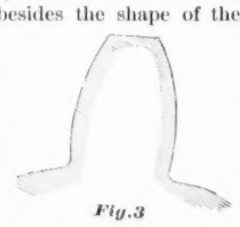


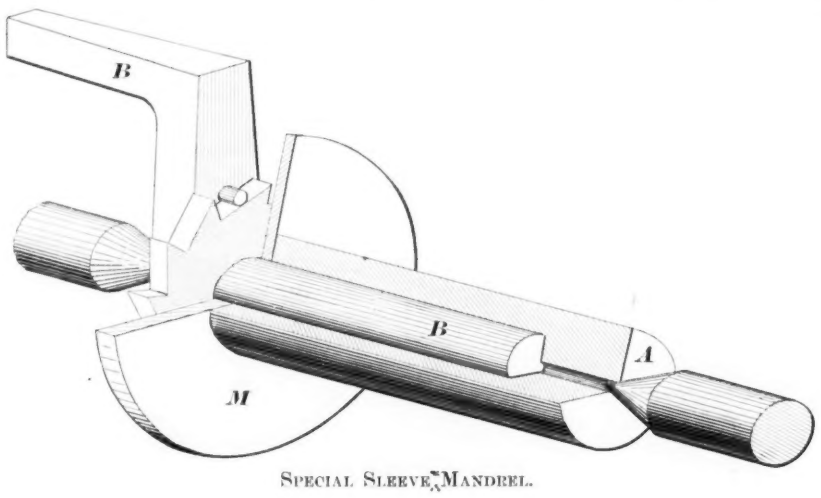
Fig. 3

FRED. J. MILLER.

Special Sleeve Mandrel.

Editor American Machinist:

The writer was recently shown a "special sleeve mandrel" now in use at the Knotter Department of the East Street Champion Reaper and Mower Shops, Springfield, Ohio. It is one of the many special appliances designed by Asa Hurd, foreman of the above-mentioned department, and with his permission I present it to your readers. In the accompanying engraving, *B B*, is the mandrel proper; and *A*, the sleeve, which fits over the mandrel. As will be seen, a small hole is drilled through the end of the sleeve to permit the air to escape in placing it over the mandrel. It will be noticed, the work to be operated upon must have some kind of a projection to drive by, as the ratchet *M*, for instance, and should be faced when bored. There being less friction on the center end of the sleeve prevents the mandrel from turning in the sleeve. The advantage of this mandrel is, you do not have to drive the work on and off.



SPECIAL SLEEVE MANDREL.

Lima, Ohio. S. R. E.

An Exemplary Machine Shop.

Editor American Machinist:

I recently had occasion to visit a shop, every feature of which seemed perfection, and a description of some of these features may be interesting to your readers.

Although I had never met the superintendent before, he gave me his personal attention and took me over every part of the works. The rooms were all high, well lighted, and perfectly well ventilated. The shafting and pulleys were above criticism—no projecting pieces that could possibly catch a man's clothing—ample room between pulleys for all belts. In short, everything of this kind in perfect condition, and I was assured that no fatal or serious accident had ever occurred in the works.

A noticeable feature was the absence of the rules and notices usually seen in shops, such as, "No washing before the whistle blows;" "No loafing in the blacksmith shop," &c., &c., down to the last one, which generally is, "Any violation of these rules will subject the offender to his discharge." Mentioning this to the superintendent, he said that all the men knew what was right without any printed rules; that he did not want, and would not have, any men in the place that needed such rules, and that he found by employing the very best class of help the cost of production was much less than that of some of their competitors, in spite of the larger wages paid, thus enabling them to employ a liberal policy all through the business, which they were satisfied was the best way. Jealousy seemed unknown among the men, from the last apprentice up to the superintendent. If one man got fifty cents more per day than the next man, this next man seemed to understand that it was because the first man was worth more, and instead of going around howling about it, he simply gave his attention to his own improvement, knowing that when he was worth the extra half-dollar he would get it. The superintendent showed a number of tools and devices invented by different workmen in the shop, for which the men had received pay when adopted for use. He seemed to have no hesitation about telling who originated different ideas, and did not claim to have gotten everything in its present fine condition unaided, but said that the company encouraged the men to improve things by paying them liberally for anything of value, and found that this policy paid well, every man giving his attention to the company's interest, knowing that it would also be his interest.

There was no "ring" in this shop; everybody on his own merits, and no special favors to any one. There was an evening-school for the boys, and a library and reading-room for everybody. I cannot begin to think of all the nice things about this shop, but when I tell where it is, everybody will know all about it—it is in Utopia! When shall we see one like it in America?

LIBERAL.

Compound Engines on Western Rivers.

Editor American Machinist:

An item in the AMERICAN MACHINIST of November 17 states that an engine recently put upon an Upper Mississippi steamboat is reputed to be the first compound engine on Western rivers.

The John A. Wood, of Pittsburgh, has been in the coal trade between Pittsburgh and New Orleans about thirteen years, and is perhaps the best known towboat on the Ohio and Lower Mississippi. She has a pair of compound condensing engines, with cylinders about 19″ and 40″ by 9 feet stroke, and carries boiler pressure at 174 lbs. (The engine dimensions may not be precisely correct.)

The J. B. Williams, of Pittsburgh, is also one of the largest and best known boats in the Ohio and Mississippi coal trade, and has compound condensing engines, which I saw on the boat in 1876, but do not remember the dimensions. C. SEYMOUR DUTTON.

Chicago, Ill.

A Milling Machine for Dressing Off the Ways of Lathe Beds.

Editor American Machinist.:

Many years ago, when machine-shop facilities were in a much cruder condition than they are now, when iron planers and many other of our modern machine tools were among the things to be, it was the practice of some machinists to dress off the ways of their lathe beds with a gang of revolving cutters, carried along the ways in a sliding carriage, the guide for the carriage being the nicely-jointed edges of two hard-wood planks strongly and accurately fixed to the sides of the lathe bed. The feeding device was simply a stout cord hitched to the carriage, with a double-turn around a slowly-revolving shaft at the end of the guides, a weight being suspended from the end of the cord to make it bite the shaft.

There is a principle involved in this primitive arrangement which modern machinists might well consider. Substituting nicely-planed iron guides in place of the plank, a simple screw-feed in place of the cord, and a nicely-fitted carriage with its gang of cutters—all according to the best modern practice—and we should have a machine it would be difficult to supersede, as a method of dressing off the ways of lathe and planer beds, and the like.

The reader will bear in mind that the weight of a gang of cutters, with its carriage, need not exceed three hundred pounds, and that in dressing off a lathe bed ten feet long, for instance, this carriage must move only about ten feet; or, if a second finishing cut is needed, twenty feet, while, according to the present planer practice, the ten-feet bed with the planer table, weighing not less than a ton, must travel not less than two miles, probably; and not only travel two miles, but it must stop and start every ten feet of the journey, or more than one thousand times. The distance here given is a hasty estimate. I think two miles is a low figure, but any good planer workman can easily give the correct one.

Facilities for manufacturing milling cutters are now such that gangs of cutters for milling almost any form can be furnished cheaply, and by having a coarse set of cutters, that can be easily sharpened, for making the first cut, a set of finishing cutters will last a long time without losing their integrity.

F. G. WOODWARD.

How to Take Apprentices.

Editor American Machinist:

We notice an article in your paper of October 27, about young men trying to get into the shop as apprentices. We find one thing that makes employers very reluctant about taking them. As soon as they get so they know anything to mention, they become dissatisfied and want to leave. This occurs as soon as they become profitable, and there is no law to hold them. We have been in the habit of keeping back part of their pay as a guarantee of good faith on their part. If they quit before the time agreed upon they were to lose it; if they complied with our agreement and served out their time faithfully, they got all the money so held back at the expiration of their time. But we find, if they are disposed to quit, they can recover the money so held back by law. We have, therefore, got up a new article governing apprentices. Instead of keeping back part of their pay, we agree to make them a present of a given amount of money at the expiration of their time. It is in the nature of a gift, and if they quit before their time is out they lose it, and cannot recover by law. You will find a printed copy of the same enclosed.

Taking apprentices is like getting married—you take them for better or for worse, and if they don't amount to anything you have got them all the same. We find that it is a good plan to take them on probation for six months, and if we find anything in them by that time we keep them; if not, we let them go. We find a great many useful things in your paper, and would not do without it.

HETHERINGTON & BERNER,
Foundry and Machine Works,
INDIANAPOLIS, Ind.

STATE OF INDIANA, } ss:
MARION COUNTY, }

Know all Men by these Presents,

That, Whereas, ... party of the first part, is desirous of entering the employ of the firm of HETHERINGTON & BERNER, party of the second part, manufacturers, carrying on business in the City of Indianapolis, Indiana, for the purpose of learning the.....branch of business, carried on by said party of the second part, and, whereas, the said party of the second part have consented, by reason of the covenants and agreements hereinafter contained, to receive the said.....party of the first part, into their employ. and to incur the obligations and perform the conditions likewise hereinafter mentioned. Now, the said party of the first part hereby agrees and undertakes to remain in the employ of the said party of the second part for the full term of.....years, beginning on the .....day of.....A. D. 18.., and ending on the.....day of..... A. D. 18.., and to employ himself diligently and faithfully in learning said.....branch of business, under the instruction and direction, and subject to the orders of said party of the second part, and to receive the wages hereinafter mentioned, and at the times mentioned, in full satisfaction of all claims for labor and service performed for said party of the second part during said term.

And the said party of the second part, in consideration of the foregoing agreements and covenants on the part of the said party of the first part, hereby undertake and promise to give such advice and instructions to the said party of the first part, during said term, as he may require in order to acquire a competent knowledge of said..... branch of business. And the said party of the second part further agree and undertake to pay to the said party of the first part the following wages, so long as he may continue in their employ, to wit:

..... Cents per hour during 1st year.
..... " " " " 2d "
..... " " " " 3d "
..... " " " " 4th "

And at the expiration of said time, unless the said party of the first part should be sooner discharged, as hereinafter provided, the said party of the second part agree and promise to pay to the said party of the first part an additional sum of .....for each hour's labor per-

formed by the said party of the first part during said term. The same to be considered as a gift or present from said party of the second part.

But it is also hereby expressly agreed by and between the parties to this agreement, that in event there should be from any cause a material reduction in the wages paid by the said party of the second part to the journeymen in their employ, that there shall be a corresponding reduction in the wages hereinbefore agreed to be paid to the said party of the first part per hour.

And it is further expressly agreed by and between the parties to this agreement, that whenever, in the opinion of said party of the second part, the said party of the first part may have violated any of the shop rules now or hereafter made by the said party of the second part for the government of their employes, or shall have been guilty of any improper or disorderly behavior in and about the premises used and occupied by said party of the second part in their said business, then and in that event said party of the second part may cancel this agreement, and discharge the said party of the first part from their employ.

ATTEST: }.....
}.....

.....

Know all Men by these Presents,

That .....

.....

are held and firmly bound unto HETHERINGTON & BERNER, in the sum of.....dollars, to be paid by the said firm, their successors, survivors or assigns, to which payment, well and truly to be made, we bind ourselves, our heirs, executors and administrators, and every of them firmly by these presents.

Sealed with our seals, and dated this..... day of.....A. D. 18..

The conditions of this obligation are such that, whereas, on the.....day of..... A. D. 18.., the said firm and.....made and entered into the foregoing agreement, and, whereas, we are desirous to secure and protect the said firm from all loss and damage they might sustain by the said..... .....failing to continue and to be retained in the employ of said firm, and to discharge and fulfill the covenants and agreements on his part, entered into in the foregoing agreement. Now, if the said.....shall continue and be retained in the employ of said firm, and perform the covenants and agreements on his part, entered into as in said agreement it is set forth, then this obligation shall be void, otherwise to be and remain in full force and virtue in law.

ATTEST:

.....

.....[SEAL.]

.....[SEAL.]

....[SEAL.]

Subscribed and sworn to before me, a Notary Public, in and for the County and State first above written, this.....day of .....A. D. 18..

.....

Notary Public.

Reminiscences of George Hollingsworth.

We here conclude the stenographic report of an interview with Mr. George Hollingsworth, part of which appeared in our issue of Oct. 20:

INTRODUCTION OF THE LINK MOTION.

Q.—Do you remember anything about the first link motion used by Rogers?

A.—Yes; it was put on an engine called the Whistler that was built about 1848 or 9, and went to the Stonington road, in Connecticut.

Q.—Was that the common shifting link?

A.—No; that was a reverse, curved, stationary link, and the block was moved by a radius rod that extended to the rocker arm, and was attached to the reversing shaft. This link was copied from engravings of an engine built by the English engineer, Brunel. I took this engine to the Stonington road, and I believe that to this time there is not an engine which has gone over that road quicker than we ran with that engine and nine cars. We ran fifty-two miles in one hour and six minutes, and stopped for wood and water. The old man was a great believer in the link, and was the first engine-builder in this country to recognize its merits for locomotive work. He tried a double link before this time, but it did not answer. The regular shifting link was tried shortly after the reverse link, and was preferred to the other kinds.

Q.—Did they have any trouble adjusting the link at first?

A.—They did not get it adjusted rightly. There was a great deal of bother with it for some time. The old man, and Swinburne, and Hudson worked together for a long time to try and find some means of equalizing the cut-off. They used to go to the drawing office at nights, and experiment with models and drawings. One night, when they had worked a long time trying the effect of different arrangements, Hudson jumped up and cried, "I have found it." He had perceived the effect on the valve's movement of moving back the hanger stud away from the center of the link arc. After this they got the valves to work square right along. Before finding out this means of equalizing the cut-off, they were in the habit of getting it nearly right by putting unequal lap on the valve.

OPPOSITION TO THE LINK MOTION.

Q.—Years ago we used to hear stories about the first link engines built for the Hudson River Railroad not being liked. Was that the case?

A.—Yes. McQueen, who was master mechanic there, was terribly opposed to the link. He took the lead in fighting against the link, and Rogers was its principal advocate. Mack ordered two engines with link motion; they were the Atlantic and the Pacific. The Pacific had one pair of six-foot drivers. The Atlantic had a smaller wheel. McQueen took the link off this engine and put on a hook motion, but she never was so smart afterwards; that is, she would not make the same speed. As they went out of the shops these were wonderfully smart engines. I used to run the Atlantic to Peekskill—forty-two miles—and make nine stops, in one hour and ten minutes. I have seen the Pacific run to Dobbs' Ferry—twenty-two miles—in thirty minutes, making five stops. The speed of the locomotive has not been improved since that time.

Q.—Was there much opposition to the link motion from master mechanics?

A.—Quite a good deal, but McQueen was the leader. I will tell you a story about that which I got from Mr. Rogers. McQueen had left the Hudson River road and gone into the Schenectady Locomotive Works. Rogers had been away out West at the opening of some railroad, and he came back in company with John Ellis and Corning. On their way they stopped over at Schenectady, and in the morning nothing would do but they must go and see McQueen. The time before this that Rogers had seen McQueen Mack had said that nobody but a fool of a mechanic would put on a link. Well, they went over to the works, and were looking round, when they saw Mack under an engine in the pit. He looked up when he saw them, and then came out from below the engine. "What were you doing in there?" Rogers says to him. Mack blushed and said, "I am trying to put a link on." Said Rogers, "Nobody but a fool of a mechanic would put a link on." "Well," replied Mack, "that is true, but we must satisfy railroad people. They want the link motion, and though I am no advocate of it I have to put it on or lose the work." So this was the way that McQueen and all the others opposed to the link came round to adopt it. The V hook was smart in getting away from a station, but the link is safer and gives less trouble.

Q.—Did you ever see link and hook-motion engines tried against each other?

A.—Yes. We built some engines to go to the Vermont Valley road. On the Keene road they had a lot of engines with the hook motion, and we used to race into Bellows Falls. Our link engines could always beat them, although there was some tall running. Before that people got to think that nothing else would do but the hook motion. Mechanics used to come from all over the country to look at the link motion. It was regarded as a curiosity. Even after it was working all right, and the link-motion engines beating those with the hooks, some men shook their heads and said, "It won't last." But it did. Unprejudiced mechanics liked it from the start, because the link was simple, though it had some faults in distributing steam

INDEPENDENT CUT-OFF WITH LINK MOTION.

Q.—I have heard that Rogers tried an independent cut-off on some engines with the link motion. Do you remember anything about it?

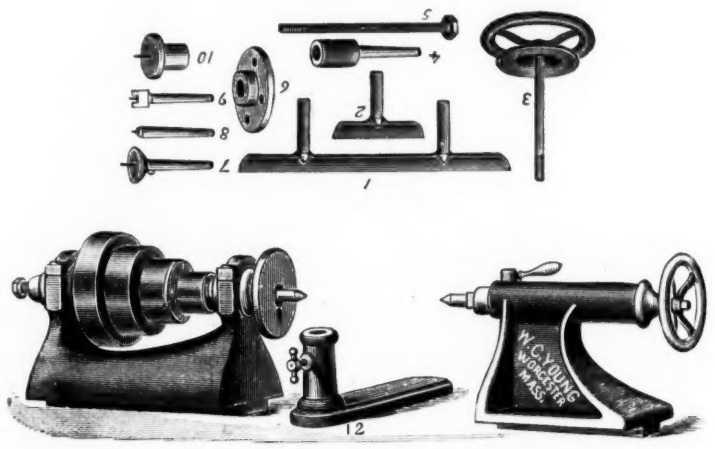
A.—Yes. It was similar to the cut-off used with the hook motion. A separate valve moved on top of a partition plate, and it was worked by a separate eccentric.

Q.—What prevented that from becoming popular?

A.—Well, it was a little complicated, and people seemed to think in those days that the link gave enough expansion of steam without a separate cut-off. The old man was always in for making engines economical, but he was ahead of the times.

FIRST SOLID ROCKER BOXES.

Q.—Was not Rogers the first to use solid rocker boxes?



YOUNG'S WOOD-TURNING LATHE.

A.—Yes. Rogers put on the first long boxes, such as are now used. That was two or three years after I joined the works. Before this the rocker had two bearings, one on the guide, the other on the frame. This was inconvenient, because when any change had to be made in the guides, the rocker had to be lined up. Rogers wanted a bearing right on the frame. He kept studying round an engine day after day, and I knew he was after something. Then he went up to the drawing-room and got out the design for the new box, which was put on the next engine built. There was a good deal of opposition to this, too, at first, for men had an idea that it would wear in the ends and bind the rocker in the middle.

EXPANSION PLATES.

Q.—Do you remember under what circumstances Rogers first used expansion plates?

A.—Expansion plates and braces were got out after a good many experiments. At that time they were trying to make iron fire-boxes take the place of copper. There had been trouble with engines that went to a road in Duchess country. It was a terribly rough road, with slab rails, and was hard on the engines. The boiler of one of them cracked between the leg and the waist. George, who was superintendent of the road, wanted Rogers to build the engines like a corn basket so that they would twist any way. Some of these men had queer ideas of what engines could be made to do. But Rogers got thinking over this matter, and after a time he got out the expansion plates. There was a great trial a few years ago about the corrugated roof business and Hudson and I had to go and testify as to the time the old man first used expansion braces.

HEATERS.

Q.—When did they begin putting heaters on locomotives?

A.—The first that I remember were put on about 1846, but they did not become common for several years after that time.

Q.—How did you keep the pumps from freezing?

A.—We kept thawing them out with burning, greasy waste. We had ever so much trouble, and frozen pumps caused no end of delay in hard weather.

Q.—Did you ever make a heater act as an injector to fill the boiler?

A.—No; I never could manage it, although I have often tried. Some engineers could do it, but the pipes had to be fixed in a peculiar way.

EARLY KINDS OF PISTON PACKING.

Q.—What was the first kind of piston packing you remember?

A.—When the Camden and Amboy engines first came here, they used to pack them with brass rings and hemp packing. They used the hemp instead of the spring.

There was a bull ring, and then they put the packing in just the same as caulking a ship.

They pounded it in with a packing stick made for the purpose. Then springs of different forms came into use.

CROWN BARS.

Q.—Did they always use the crown bars for fire-boxes?

A.—They have always used them since I knew anything about the shop. At first they used a solid bar, drilled out for the bolts to go through the cheek. Then the old man got into the way of using two bars, ⅝"x5". If it was a big engine, he would increase the size of the bars. He used to tie them together with a T-headed lap-over on top.

CAST-IRON FLUE THIMBLES.

Q.—Do you remember anything about the first invention of cast-iron thimbles?

A.—Yes. Melank Mason, who was the first engineer for the New Jersey Transportation Company, was the first to discover the advantage of the cast-iron thimble. He was greatly plagued with leaky flues, and he thought of trying cast-iron thimbles. He got them cast and turned, and drove them into the flues and they kept tight. He and Hudson were great friends, and they went experimenting together on the relative size of cast and wrought-iron thimbles. They heated the thimbles red-hot, and after they were cooled down gauged them as closely as they could get a gauge to measure. By this means they found out that the cast-iron thimbles remained about the same size, and those of wrought iron got smaller.

FIRST REFLECTOR HEAD-LIGHT.

This Mason was the inventor of the present form of head-light. He did not like the old style because it did not throw any light ahead. So he got trying what he could do with different forms of glasses. He tried double convex glasses of varied kinds, but they did not satisfy him. Then he tried reflectors.

The first one he tried was square, and he decided that was the right direction to work in. His next improvement was a half globe, and then he took the small end of an egg as his pattern, which was the shape settled upon.

Young & Co.'s Wood-Turning Lathe.

We represent with this the iron work of a wood-turning lathe made by W. C. Young & Co., Worcester, Mass. These parts are adapted to be mounted on wooden shears, but are made with the same care as iron bed-lathes, and of equal strength. They are made in sizes from 10 to 24-inch swing, and with fixtures as shown, including, besides, countershaft and hangers complete with pulleys and belt shifters. The larger sizes, when required, are furnished with a back face-plate for pattern makers' use. The wooden shears, with iron legs, are furnished if desired. The two smaller sizes have balanced three-section iron cones; the larger sizes four-section cones, the small section of iron and the other three of wood, with iron flanges keyed to the spindle at each end.

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NEW YORK, DECEMBER 1, 1883.

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The price of the AMERICAN MACHINIST was reduced, beginning with issue of Nov. 3, to five cents a copy, or $2.50 a year. Readers who do not find copies for sale by newsdealers in any part of the United States or Canada where they have asked for this paper, will confer a favor by dropping us a line about it.

Shop Benefit Associations.

Some machine shops have "benefit societies" among the workmen. Every member of the society puts a portion of his wages, weekly or monthly, into a common fund for the support of members and their families in case of sickness or death. These societies are excellent if kept up according to some approved plan. In some cases the proprietor of the shop promotes the organization of a benefit system, in which all the men therein employed participate. E. P. Allis, proprietor of the Reliance Machine Works of Milwaukee, advised his employes to organize such an association in their own interest, which they did very promptly, as Mr. Allis agrees to contribute personally at the end of each month, an amount equal to the total subscribed to the fund by all the workmen in his employ. The convenience and needed relief such a fund frequently affords are enough to commend its establishment. While many mechanics save a portion of their earnings against the proverbial "rainy day," a still larger number, for various reasons, do not. When sick or disabled, these men have no resources to fall back upon, unless they are members of some association organized upon the benefit system. If no such association exists in the shop where they work, the chances are that many of them will join a trade union, most of which include a system of benefits for disabled or unemployed members. It has been very widely asserted that trades unions are organized mainly out of hostility to employers. We do not believe the assertion. Were it not for the benefit system, trades unions would be few and small, instead of which they are multiplying in numbers and extending their membership. This fact is worth the serious attention of large employers of workmen who believe the trades unions hostile to their interests. What plan will they offer by which their employes can have the advantages now afforded by belonging to a trade union? Mr. Allis seems to have solved the problem for his establishment. It has been solved in a similar manner by a number of other manufacturers throughout the country, and a still greater number have apparently left it to solve itself.

It should be remembered that the shop benefit association is virtually an accident insurance company. As long as each workman pays his dues (or premium) and *remains employed in the shop*, he is entitled to benefits, if he becomes disabled. Where a good sized fund has been accumulated, the workmen have extra inducements to keep their situations. This is to the advantage of proprietors as well as of workmen. When a good shop force has been secured, it is desirable to have as few changes as possible. The plan works well in several large machine shops both east and west, and would do so in others if once adopted.

Indirect Advantages of Electric Lighting.

There may be some question as to the ultimate direct utility of the electric light, but there is none as to the incidental advantages that have resulted from the demand for closely regulated engines—especially those of small and medium power—to meet its requirements. Indirectly, the electric light has wonderfully improved the steam engine governor, and forced, to good purpose, a consideration of the fact that there are many things beside the governor that have to do with controlling speed. All of this is having, and will continue in a greater degree to have, a beneficial effect on the economy of manufacture. To say that a steam engine governs closely enough for electric lighting has already become meaningless, although it is only a short time since it had a good deal of significance. But it has stimulated another pertinent inquiry, viz.: does it govern closely enough for good economy in manufacturing? The economy of uniform speed in textile manufacturing has been understood for years, but there has been a vague general impression that it was only in these industries, and one or two others, that it was especially important. Now that closely governed engines are common, their economic value in smaller and more numerous industries is becoming better known. Locate a thousand machine tools—lathes for instance—in one room, working on one class of work, and the conditions of textile manufacture will be more nearly approximated. Under these conditions, the most economic speed at which to run them will soon be determined, as well as the loss from adopting a speed from five to ten per cent. less to cover the fluctuating speed of the motive power. The loss would, of course, be equally great if a thousand lathes were situated in ten or a hundred rooms, in as many localities, but it would not be equally noticeable. The instance of machine tools is taken simply because it is a handy one, and not because there is more loss from irregular speed there than otherwheres. The loss is undoubtedly less there, than in many instances that might be noted, but anywhere irregular speed means less production, and generally inferior quality. The reason why this has been so well recognized in textile manufacture is because sometimes close competition and generally the magnitude of the industry have brought about systematic observation. The tendency in all manufacture is towards exactness of operations, and the foundation of this is uniform speed. If electric lighting were to accomplish nothing more than to make this common, it would have served a valuable purpose.

Josh Billings says: "Thare iz a grate deal ov ekonemy that there iz no profit in. I have known folks to sett a large-sized hen on 2 eggs, just to be saving."

Once in awhile we get a sample of this kind of economy in a machine shop. A big, expensive building, only half equipped for productive work, is not apt to bring in much profit to the owner. Where enough paying work can be obtained to keep the whole shop full, good economy would seem to warrant completing the equipment.

Again, we see a good shop filled with old, worn, and inefficient tools, upon which it is impossible for the best workmen to get out the proper quantity or quality of work. It may be a kind of saving to pay full wages to all the men to keep these tools in operation, but it looks very much like the policy of setting a good-sized hen on two eggs.

Since starting the cars on the Brooklyn bridge and up to the present time, the grip for the cable has caused innumerable delays, and has been the text for much unfavorable comment. Undoubtedly the problem in this respect presented difficulties that could not well have been foreseen, and probably those disposed to indulge the prerogative of fault-finding have not always considered how much easier it is to point out a failure than to foretell one. It would seem, however, that sufficient time had elapsed in which to have made such alterations in the grip as should have been suggested by experience with its objectionable features, but it still seems to be unsatisfactory in its operations, so that without injustice to any one it may be inferred that it possesses inherent faults that modifications of construction will not satisfactorily remedy. In our previous publication of the details of the traction machinery, we purposely omitted the gripping device. In this issue we make room for an illustration of a new grip, now being appplied to one of the bridge cars. Mr. Mathesius, the inventor of this grip, is the mechanical engineer who has had charge of constructing and erecting most of the bridge machinery, and those who are acquainted with his ability and with his experience in the construction and operation of wire rope traction roads expect that he will in this instance solve the problem, so far as the grip is concerned. His grip possesses the merit of simplicity, and seems to be quite free from the serious objections of destructive action on the rope, and on the faces of the dies. We shall await the verdict of time in its operation with a good deal of interest.

We regret to observe that the editors of some of our exchanges who have been laboriously contending for "relief from war taxes" are urging either the reduction or the complete abolishment of the tax on whiskey. The result of the crusade is bound to be disappointing to the ardent workers. Even if a sufficient number of congressmen should become so filled with the spirit of progress (from Bourbon county) as to vote to take off the whiskey tax, our clamorous contemporaries would not be able to "smile" at the bar one cent cheaper than before. The advantage would be with the dispenser of exhilarating fluids, and the chances are that he would not be any more willing to "hang it up" than he is now. Taken altogether we cannot see that the advocates of this particular "reform" would experience any "relief."

Big Lathes and the Tariff.

One of the largest and best known machine tool building establishments in Great Britain is that of Thomas Shanks & Co., Johnstone, Scotland. In a letter received by us a few months ago from William Shanks, the head of that establishment, after referring to a huge lathe they had built for parties in Cleveland, O., he says: "Were it not for your wretched tariff, we are confident that the day of such lathes being manufactured in America is very far in the future." We agree with him in that view. Take off the 45 per cent. duty on machinery, and there would be no inducement whatever to invest capital in building such a class of heavy machine tools in this country. As it is, preparations are being made to build such lathes here, and in the course of a few months we hope to be able to show our readers what has been accomplished in that direction. The Cleveland lathe is quadruple geared, has four foot swing and a sixty foot bed. Five cutting tools are used at once. The Shanks lathe, we illustrated in detail two weeks ago, has only four tool posts.

When one employs apt language to express an idea, he may, in the interest of science, expect to be copied if not quoted. The "anvil" principle in the construction of machine tools has come to be a very general form of expression, and in order to show, so far as we know, where it originated, we give the following from the AMERICAN MACHINIST of November 27, 1880, it being an extract from the report of a paper read by Charles T. Porter before the first regular meeting of the American Society of Mechanical Engineers:

"But what is the standard of strength? The anvil affords perhaps the best illustration. It is a strength enormously beyond that which prevents a tendency to chatter, a strength that even under the heaviest labor prevents the least vibration of any part of the tool, or any indication of effort, more than if the object being cut were a mass of butter."

Although the "anvil" principle has been extensively enlarged upon since its use by Mr. Porter, the above tells all that has ever been told by its employment. Any amount of spreading out cannot add to its force; in fact, it is one of those happy expressions that tells the most when used "solid."

We receive a large number of letters and postal cards from parties who do not sign their names. As we do not take any notice of anonymous communications, these go promptly into the waste paper basket. Whether a question is asked or a method for doing work suggested, we must know who the writer is before noting the matter in print. The name of the writer need not be published—this is at his option.

Returns of the vote in the State of New York on the proposition to abolish contract labor from the prisons are very slowly figured up. Such an overwhelming majority was cast for the proposition that the "leading" daily papers which have been laboring in the interests of the contractors, are very much averse to letting the whole force of the ballot be known at once, preferring to "break the news gently." Over 99,000 majority was given for the proposition in this city alone.

During a recent visit to the ship building yards around Philadelphia a representative of the AMERICAN MACHINIST heard gratifying reports of the prospects for work. Iron ship building is especially active, and the low prices of iron enable our builders to compete with European ship builders. A significant feature about the yards is the increase of good machinery for facilitating the work.

Literary Notes.

THE TINMAN'S MANUAL AND BUILDER'S AND MECHANIC'S HANDBOOK. Seventh edition. By J. R. Butts. Boston: Cupples, Upham & Co., Publishers, Old Corner Book Store.

This book contains rules, illustrated by diagrams, for laying out from the sheet of metal a variety of articles made by the tin and sheet metal worker, together with much that is valuable relating to these trades. Also the composition of varnishes, builders' cements, and a great variety of miscellaneous receipts, compositions, and alloys. Chapters are devoted to mensuration, practical geometry, drawing, utility of the slide rule, strength of materials used in construction, motion, properties of steam, &c., &c. Tables for the use of smiths, millwrights, and engineers are given, together with a variety of useful information, original and selected. It is well worth the small price for which it sells, viz., $1.25.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common sense methods.

(374) R. S., Petersburg, Va., asks: What are the heating qualities of exhaust steam as compared with live steam? *A.*—The heat in ordinary steam is according to its pressure, whether it has passed through an engine or not. As a matter of fact, the greater part of the heat that is in the steam when it leaves the boiler passes out with the exhaust from the cylinder, and can be most economically utilized for heating purposes.

(375) C. N. B., Wallingford, Vt., asks: Would it be possible to make a worm and wheel work, the worm being curved so as to fit one-half the circumference of the wheel? *A.*—It might be possible to do this in some way, but not practicable. In the Hindley system of worm gearing, the worm is made to embrace a portion of the circumference of the wheel—say one-sixth of the circumference—as you suggest.

(376) L. E. M., Waynesboro, Pa., asks: In chasing taper work in a lathe that has no taper attachment, should the tool be set to the turned surface, as in straight work? *A.*—No; the tool should be set so as to cut the thread at right angles to the axis of the piece.

(377) C. L. S., Syracuse, N. Y., writes: I am in charge of a 75 horse-power engine and boiler, and would like to improve myself as an engineer. I shall have three months' leisure this winter. Would you advise me to go to some mechanical school for that time; and if not, what would you advise me to do? *A.*—The time is so short that we should hardly advise going to a technical school. If, as we assume, you are not a machinist, it would be a good plan to offer your services for nothing to some steam-engine builder, and make yourself generally useful in helping around the putting together of engines and putting them up in place. If you are a machinist, and want information about running and firing, spend the time with some competent engineer in charge of engines and boilers. In any case, begin now to spend your leisure time in reading and studying the subject, and do not be afraid to ask questions of those who know more, or less, than you do.

(378) E. E. L., Allegheny, Pa., writes: Some time since I wrote, asking you what pressure a piece of glass 10″ thick would bear and you gave me the crushing strength. What I want to know is, what pressure a piece of glass 46 inches square will stand, supported on each side, the distance between the supports being 40″? *A.*—According to experiments by Trautwine, a piece of glass one inch square and one foot in length will break with a load of 170 pounds at the center. If the load is evenly distributed, it will sustain twice that weight, or 340 pounds. To find what any other piece will sustain: Square the depth in inches, multiply this by the breadth in inches, and this product by 170; then divide the last product by the distance between supports in feet. This will give the breaking weight if applied at the center; if loaded uniformly, multiply this by 2 for breaking weight. We understand your piece to be 46 inches wide and deep, hence

$$\frac{46^2 \times 46 \times 170}{3\ 10\text{-}12} = \text{breaking load.}$$

if loaded at the center. To be exact one-half the weight of the glass between supports should be deducted from this, and if the load is distributed over the whole surface, multiply by 2.

(379) E. H., Lansing, Mich., writes: I have the circular of a steam-engine builder, in which is a table of the indicated horse-power for each pound mean effective pressure at piston speeds from 10 to 700 feet per minute, and for cylinders from 4 to 16 inches diameter. I have copied these, and then to extend the sizes I have adopted the following plan: By the table I find, for instance, that at 10 feet piston speed the indicated horse-power of a 10-inch cylinder for one pound mean effective pressure is .0238. I want to find what it will be for a 20-inch cylinder, which I do as follows:

$$\frac{20^2 \times .0238}{10^2} = .0952.$$

This seems to be right, but in the table referred to the power of one pound of steam in a 4-inch cylinder at 10 feet piston speed is given as .0038, and of a 16-inch cylinder as .0466. By my plan the power of the 16-inch cylinder would be .0608. I send you a copy of the table. Is it correct? *A.*—Your plan is all right. The power of the 16-inch cylinder as quoted is wrong. A 16-inch cylinder is sixteen times the area of a 4-inch cylinder, and .0038x16 = .0608, the corresponding power of a 16-inch cylinder The horse-power of the 16-inch cylinder, if, as you quote it, is given wrong at 10 feet piston speed, and at some other speeds. We would suggest that you take the horse-power of a 10-inch cylinder as a basis, and calculate other sizes by your method.

Business Specials

Transient Advertisements, 50 cts. a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Match Machinery, F. Chillingworth, New Haven, Ct.

F. VanWinkle, Mech. Engin'r, 22 Cortlandt St., N. Y.

James W. See, Consulting Engineer, Hamilton, O.

Steel Name Stamps, &c. J. B. Roney, Lynn, Mass.

Patterns & Models, G. D. Lambert, New Haven, Ct.

Presses & Dies, Ferracute Mach. Co., Bridgeton, N.J.

"Tack Machinery"
Willets Manufacturing Co., Providence, R. I.

Patents.—Franck D. Johns, Att'y at Law & Solicitor of Patents, 617 Seventh St., Washington, D. C.

The latest Improved Match Machinery is made by the White Machine Co., Waterbury, Conn.

Pattern and Brand Letters. Vanderburgh Wells, & Co., corner Fulton and Dutch streets, New York.

Consulting Engineer and Mechanical expert, C. C. Hill, 144 LaSalle street, Chicago, Ill.

Chas. T. Porter, Mechanical Engineer, Tribune Building, (Room 58,) New York City.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

For sale, lathes of best designs from new patterns. George A. Ohl & Co., E. Newark, N. J.

Lyman's Gear Chart. How to lay out gear teeth. Price 50 cents. E. Lyman, C. E., New Haven, Conn.

Wood Engraving done in best manner. Designs furnished. Edward Sears, 48 Beekman St. New York

Foot Power Machinery, for workshop use, sent on trial if desired. W.F. & John Barnes, Rockford, Ill.

New Books, relating to steam, the steam engine, mechanics, machinery, and engineering. Send for catalogue. Fred. Keppy, publisher, Bridgeport, Conn.

Jack pump and ladder chain machines, 40 to 80 links per minute, direct from coil. The Gaylord, Cross & Speirs Company, Waterbury, Conn.

Guild & Garrison's Steam Pump Works, Brooklyn, N. Y. Steam Pumping Machinery of every description. Send for catalogue.

Slide Valve Working Models. Send for circular. See notice in this paper October 13, page 9. E. E. Roberts, 107 Liberty Street, N. Y.

The Complete Practical Machinist, $2 50; the Pattern Maker's Assistant. $2.50: Mechanical Drawing Self-taught, $4 00; books for practical machinists. Address, Joshua Rose, Box 3,306, New York City.

Business men furnished stenographers, who are machine operators, without charge for my services. Shorthand taught by mail. Caligraphs sold; special inducements offered; correspondence solicited. W. G. Chaffee, Oswego, N. Y.

Chordal's Letters.—John Wiley & Sons, 15 Astor Place, New York, have now ready a new and enlarged edition, with six additional plates, of Chordal's Letters, comprising the choicest selections from the series of articles entitled "Extracts from Chordal's Letters," which have appeared in the columns of the AMERICAN MACHINIST; with a steel portrait of the author, and upwards of fifty original illustrations by Chas. J. Taylor. One volume 12 mo. of nearly 400 pages, cloth, $2.00. Will be mailed and prepaid on the receipt of the price.

"HOW TO KEEP BOILERS CLEAN."—A book of seventy-two pages, telling how to prevent scaling, foaming, priming, and burning, with other valuable information, will be sent to any address FREE of postage, by James F. Hotchkiss, 86 John street, New York.

Any of our readers who have complete files of Volumes I. and II. in good condition, bound or unbound, can probably find a purchaser by addressing us, and stating the lowest price they will accept. AMERICAN MACHINIST PUBLISHING COMPANY, 96 Fulton street, New York.

Patent "Common Sense" Binder for the AMERICAN MACHINIST holds 52 weekly issues in good shape. Sent to any address, in the United States, by mail for one dollar. To Canada and foreign countries 75c., the purchaser to pay custom-house duties and express charges. American Machinist Publishing Co., 96 Fulton street, New York.

Manufactures.

The Chicago Die and Machine Works expect to enlarge their capacity for turning out work.

Ames & Frost will erect a four-story factory, to cost $8,000, at 215 Cherry Avenue, Chicago.

Over five hundred hands will find employment next spring in the Plano, Ill., agricultural machinery works.

The American Meter Company, 512 West Twenty-second Street, New York, will soon build an extension to their shop.

Catherwood Robinson is about to erect a three-story addition to his factory at 809 North Nineteenth Street, Philadelphia.

W. F. & John Barnes, Rockford, Ill., are building a foundry 50x150 feet, to be run in connection with their machine shops.

The Tuerk Hydraulic Power Company, Sycamore, Ill., capital $60,000, is a new concern that will manufacture water motors.

The Litchfield (Minn.) Board of Trade guarantees a good bonus for the establishment of a machine shop and foundry at that place.

A street car manufacturing company is to be established in a short time at Minneapolis, Minn., with a capital of $100,000.

A new cotton mill company has been organized at Madison, Ind., and $50,000 out of a required $100,000 subscribed to the stock.

The Innes Manufacturing Company, Oil City, Pa., write us that the demand for their engines is on the increase. They sold 81 in October.

A three-story brick factory, to cost $11,000, is to be erected on Fiftieth Street by Rosalie Steinhardt, of 239 West Twenty-fourth Street, New York.

The manufacture of barb wire fence seems to be as brisk as ever in the West. Several mills are enlarging and improving their plants.

The project for a new tin-plate mill at Hubbard, O., is taking definite shape. It is expected to employ 400 men. It is known as the Pioneer Iron, Tin, and Terne Plate Company.

At the Atlas Works, Pittsburgh, Pa., a pair of large blooming shears are now making for the Edgar Thomson Steel Works. The bed-plate o it will weigh 32 tons.

The East Tennessee, Virginia & Georgia Railroad Company has purchased 100 acres of land near Knoxville, Tenn., on which to erect shops for the entire system of roads.

The St. Louis and San Francisco Railroad Company is erecting a round-house in the western suburbs of St. Louis. Their repair shops will probably be located at the same point.

The I. P. Morris Company, Philadelphia, have several of their large blowing engines in course of construction. They also have some marine engine work on hand, and their full force of men is kept busy.

The Maumee Rolling Mills, Toledo, O., are being put into shape for starting up soon. The main building, covering 362x200 feet, is completed, as are also the machine shop, 32x54 feet, and the foundry, 50x64 feet.

A stock company has been formed in Louisville, Ky., with Phil. Diehlmann at the head, to build an immense lager beer brewery. The stock is $500,000. Frank Fehr will locate the building and manage the business.

The National Iron and Brass Works, Dubuque, Ia., are making a new drill press which is said to have many new and valuable features. They are now making twelve of them for T. S. & A. J. Kirkwood. —*Industrial World.*

The Harrison Steel Company, having made arrangements to pay royalty to the Bessemer Steel Association for using Reese's patent, will proceed to erect their extensive works at Harrison, Ill., a few miles east of St. Louis.

The Westinghouse Company (formerly G. Westinghouse & Co.), manufacturers of threshing machines and engines, Schenectady, N. Y., have issued a new illustrated catalogue, in which several new and improved machines are shown.

The Automatic Spring Car Motor Company has recently been organized in Philadelphia, with a capital of $2,000,000. A car is being built which will cost about $1,000, and will be provided with sets of springs controlled by a lever. When the springs are wound up, it is said they will propel the car for ten miles. The springs will be sixty feet in length, and encased in cylinders.

The Cartersville Car Company, of Cartersville, Ga., has been reorganized and transferred to Anniston, Ala., under the name of the Anniston Car Factory. They have large capital and greatly increased capacity to build all kinds of cars for railroads.

The Joliet (Ill.) Iron and Steel Company have a large order from the C. B. and Q. Railroad Company for rails to weigh fifty-six pounds to the yard, and are running full time and force, with fair prospects of continuing through the fall and winter.

Fall River, Mass., with a population of 55,000, has fifty-three mills for the manufacture of cotton goods; has one-seventh of all the spindles in the country, and produces over three-fifths of all the print cloths made in the United States.

The Avery Planter Company, of Peoria, Ill., has been incorporated with a capital of $200,000. The corporators are R. H. Avery, C. W. Avery, and others. The business of the company will be the manufacture of the Avery Corn-planter, and other agricultural implements.

The New York, West Shore, and Buffalo Road has box cars of 50,000 pounds capacity. They were built at Pullman, rest on a heavy truck, have double-action brake, and are supported in the center by four iron trusses running lengthwise of the car.

Brehmer Bros., Philadelphia, find they can cut gear-wheels out of crucible steel with the Bilgram Evolute gear-cutter. They are receiving an active demand for cutting gears of all descriptions with this machine. The firm is very busy, mostly with the making of special machinery.

The National Car Builder says: The New York Locomotive Works, Rome, N. Y., report business very good. They have orders on hand that will keep them busy till March. Large additions have been made to their foundry and storeroom, and they are also putting in new machinery.

The New England Railroad will soon concentrate their shops at East Hartford, Conn., and hope to get them running there by January 1. Those at Norwood, Mass., will be run on a much smaller scale, and those at Hartford discontinued. Several hundred men will be employed at the new works.

The American Ship Building Company, Philadelphia, have just launched an iron vessel of 2,000 tons, and they have another ship of the same size nearly plated. There are seven iron vessels in the yard in various stages of construction. Four tugboats being built will have compound engines.

The *Denver Journal of Commerce* says: "There is at the present moment, a hundred thousand dollars' worth of mining and milling machinery in progress of completion in the various foundries and shops of the city. Every lathe, and hammer, and forge is taxed to its utmost to keep pace with the fast coming orders."

The Union Safety Frog and Switch Company recently organized for the manufacture of general railroad appliances. The capital stock is $100,000, and the directors are G. B. Starts, H. I. Miller, C. T. Newcomb, Edward Hill, and W. W. Mansfield. The manufactory will be located at Richmond.—*Indiana Manufacturer.*

A party of Boston capitalists are looking up a site in Virginia for a large cotton mill. They have proposed to subscribe towards the capital $750,000, leaving to be subscribed $250,000, of the proposed $1,000,000 capital, by the community where the company locates. Lynchburg is making an effort to secure it.

Moore's Water Tube Boiler Works, which were formerly located in the Hoen Building, are about to engage in the manufacture of these boilers in the large building No. 42 North Holliday Street. They propose to equip their works with special machinery and tools adapted to their specialty.—*Baltimore Manufacturers' Record.*

J. Stevens & Co., Chicopee Falls, Mass., have issued a small illustrated pocket catalogue and price list of their calipers, dividers, gauges, countersinks, &c., for machinists. Their tools are well known and extensively used. They offer to mail post paid on receipt of price any tool in the list. Catalogues will be sent free to any one upon application.

The new factory of Peter Gerlach & Co. is of the following dimensions: Main building, 100x52, three stories high; blacksmith shop, 30x32, one story high. The new shop is provided with an elevator and new and improved machinery to meet their increased demand for saws, ice tools, tight barrel staves, heading and barrel machinery.—*Cleveland Trade Review.*

Articles of incorporation have been filed in Camden, N. J., by the Camden Iron Works, with a capital stock of $400,000, $300,000 of which is set down as subscribed. The old works of Jesse W. Starr have been purchased. The productions will be iron castings and machinery. They will employ over fifteen hundred hands, more than half of this number being skilled men. Richard Wood, of Philadelphia, will be president of the company.

Keuffel & Esser, 127 Fulton Street, New York, have issued a new and very complete 247-page catalogue of drawing materials. It is fully illustrated, and embraces about everything required in a drawing room; also some mathematical instruments. They will send the book (cloth bound) post-paid on receipt of 50 cents, or a sample book of drawing paper for 15 cents. One leaf of the book is a fine specimen of blue process print.

Machinists' Supplies and Iron.

NEW YORK, November 15, 1883.

The supply business is easy, but cannot be characterized as dull. P. C. Holmes & Co., Gardiner Me., have issued supplements to their catalogue of gear-wheel patterns, adapted to be pasted to stubs in their regular catalogue.

In American iron the transactions are small. We quote: No. 1 X Foundry, $20.50 to $21, with some choice brands $0.50 to $1.00 higher; No. 2 X Foundry, $19 to $19.50.

In Scotch pig sales are slow and unsatisfactory, with a tendency of prices to favor buyers. We quote Coltness, $23; Glengarnock, $22; Gartsherrie, $23; Summerlee, $22.50; Eglington, $20.50—all at yard.

Antimony—Hallett's brand, 8⅞c. to 9c.; Cooksons, 10c.

Copper—Lake, 15c.; other brands 14¼c. to 14⅝c.

Lead is in slight demand at 4c.

Spelter—Refined, 8c. to 8¾c., with but little activity.

Tin—Small demand, with a tendency to lower prices. We quote for jobbing lots—Banca, 21½c.; Straits and Malacca, 19⅝c. to 19½c.

✲WANTED✲

"Situation and Help" Advertisements, 30 cents for each seven words (one line) each insertion. Copy should be sent to reach us not later than Thursday morning for the ensuing week's issue.

Partner wanted in a well-established machine business. Address, Sunny South, Chattanooga, Tenn.

Wanted—Employment by a young man who has served his time at pattern making. Address C. H. G., pattern maker, Bay City, Mich.

A good jobbing machinist and draughtsman desires a suitable situation. Address Frank, care AMER. MACHINIST.

Wanted—To correspond with traveling men who have business with users of steam and machinery. Men traveling in the Middle, Western, and Southern States preferred. Eagle Iron Works, Detroit, Mich.

Wanted—A first-class mechanical and hydraulic engineer, as superintendent of a large manufacturing establishment; must understand draughting and machinery. Address Gould's Manufacturing Company, Seneca Falls, N. Y.

An excellent draughtsman on locomotive work wishes a change. Am a good mechanic and accustomed to manage men. First-class references. Address "Locomotive," care of AM. MACHINIST office, 96 Fulton Street, New York.

Wanted—A situation as foreman moulder, by a first-class, practical man; thirty years' experience in the busines; accustomed to all classes of work—core-making, mixing, and melting of metals—construction of patterns. References. Address J. K., AMERICAN MACHINIST.

Wanted—A mechanical engineer and draughtsman, who is thoroughly acquainted with the construction of first-class automatic engines, and has had much experience with portable and traction engines, and accustomed to manage men, will be open for engagement by next New Year. Address D., 101 AMERICAN MACHINIST.

Manufacturing property for sale, 30,000 feet floor space, competing point for four trunk lines railroads, switch from door. Write for terms and description B. W. Payne & Sons, Corning, N. Y.

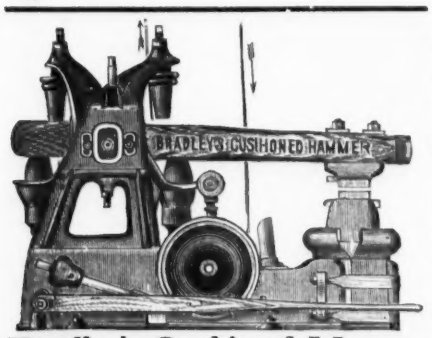
Wanted—A planer 24x24 inches by about 10 feet; second hand; must be in good order. Please state lowest cash price, and where to be seen. Address P. O. Box 1791, New York City.

Wanted, machinery to build—Parties having machine, blacksmith, and bolt shops combined, are desirous of more work. Estimates furnished for all kinds of work. Special prices to responsible parties. Address B. B. B., AMER. MACHINIST, New York.

OUR LATEST CATALOGUE

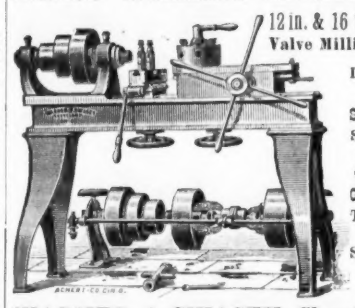
Of Scientific Text Books and Industrial Works (48 pages), including our editions of John Ruskin's Works, will be mailed free to any one ordering it.
JOHN WILEY & SONS, 15 Astor Place, New York.

HORACE THURSTON, 84 Clifford St, Providence, R. I.
MANUFACTURER OF
FINE TOOLS & SPECIAL MACHINERY.
Jewelers' Rolls and Flattening Dies accurately ground and lapped. Index Drilling, Irregular-formed Cutters and Gauge Making, Bevel and Spur Gear Cutting, up to 6 dia. 4 pitch Fluting Taps, Reamers, and Plungers. Having put in a line of Brown & Sharpe Mfg. Co.'s tools, I am prepared to do work of a character not done in ordinary machine shops.



Bradley's Cushioned Hammer
Stands to-day WITHOUT AN EQUAL.
OVER 800 IN USE.
BRADLEY & CO., Syracuse, N. Y.
ESTABLISHED IN 1832.

BRASS WORKING MACHINERY.



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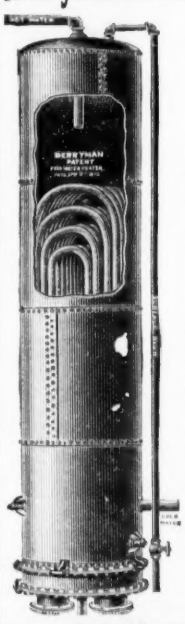

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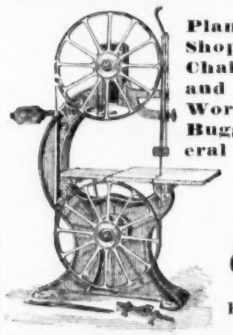

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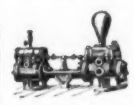

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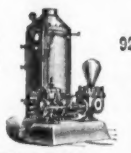

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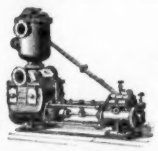

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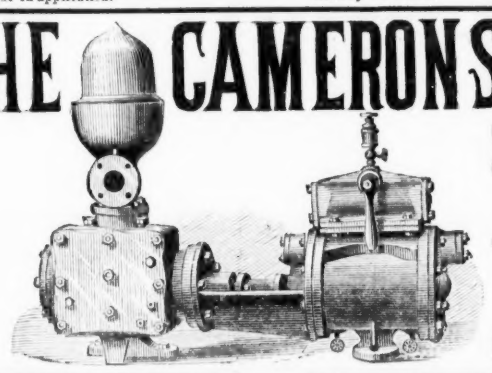

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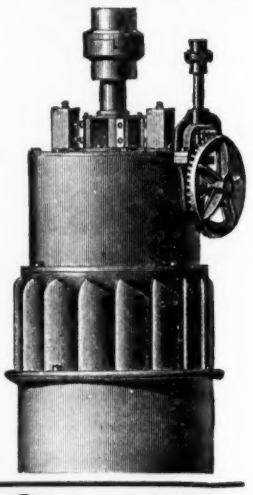

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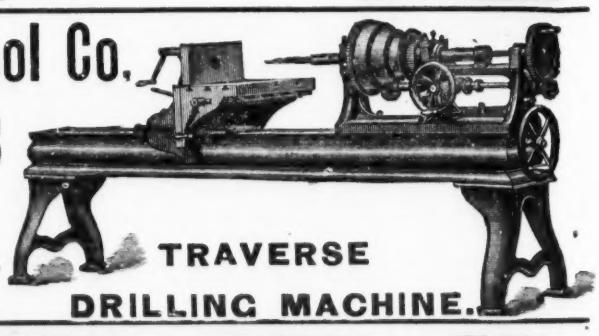

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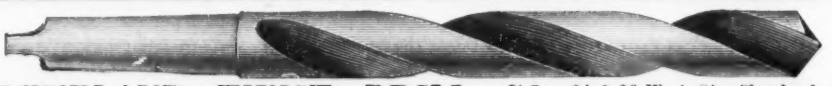

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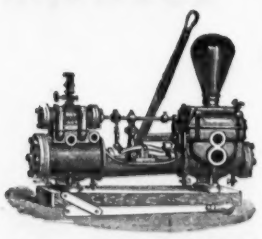

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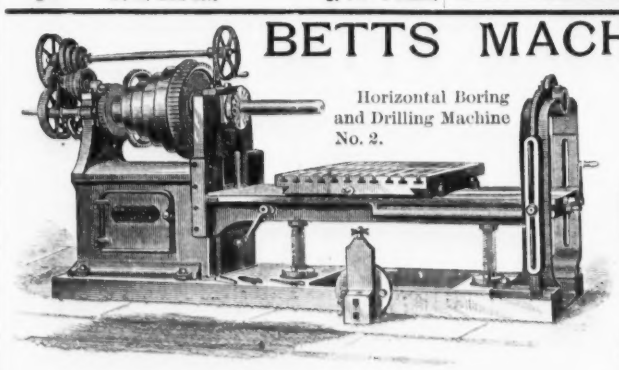

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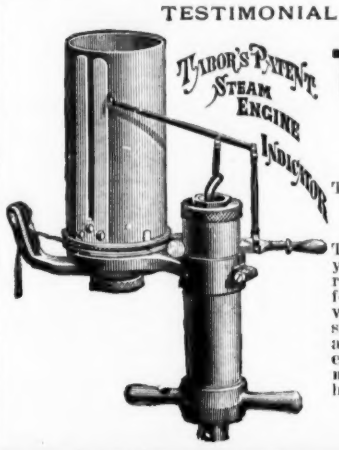

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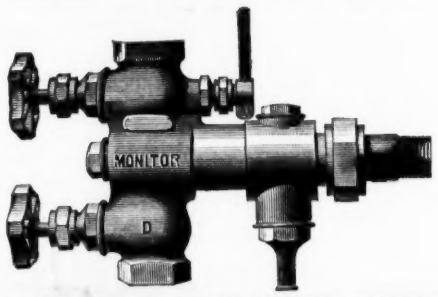

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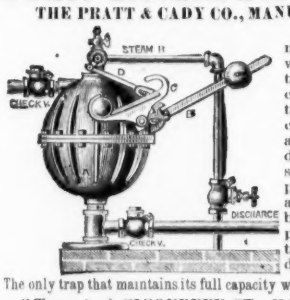

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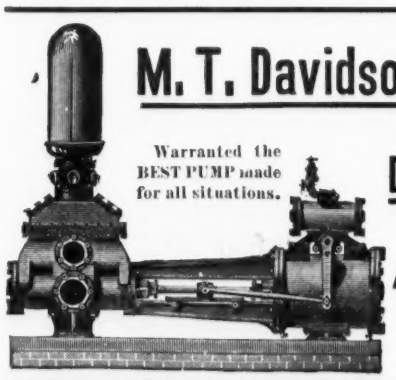

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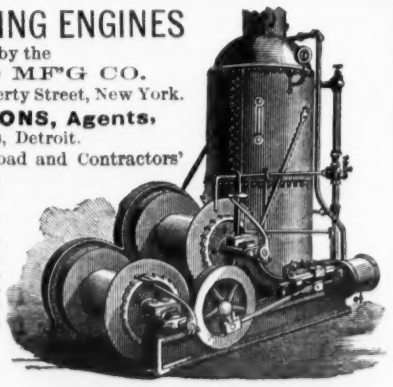

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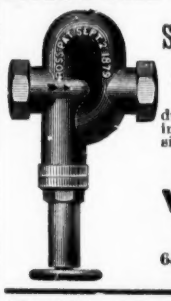

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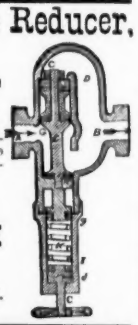

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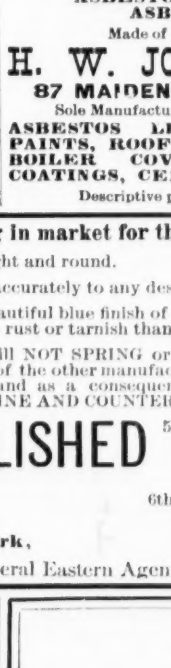

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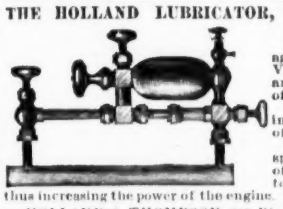

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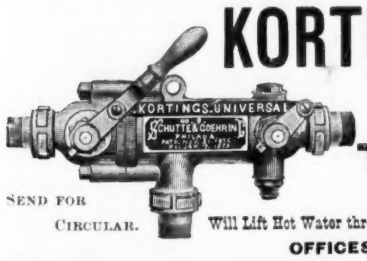

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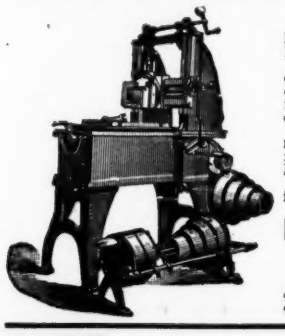

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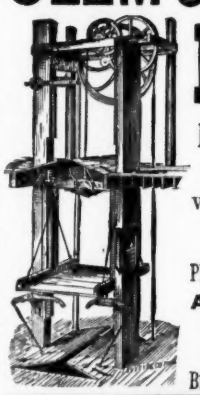

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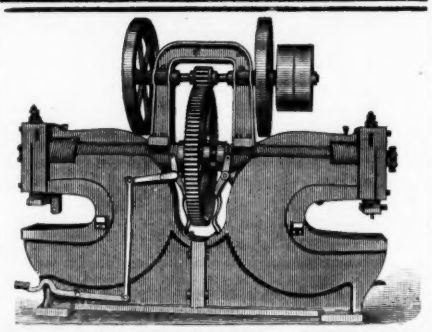

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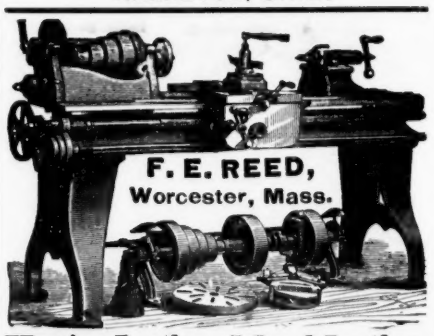

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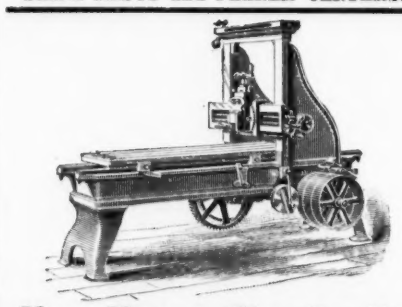

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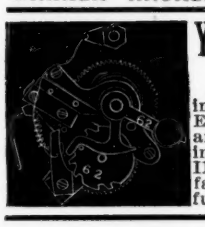

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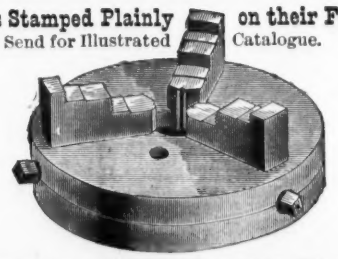

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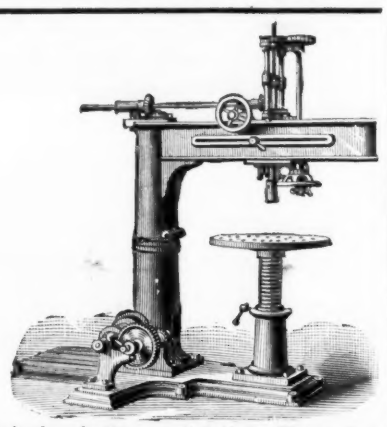

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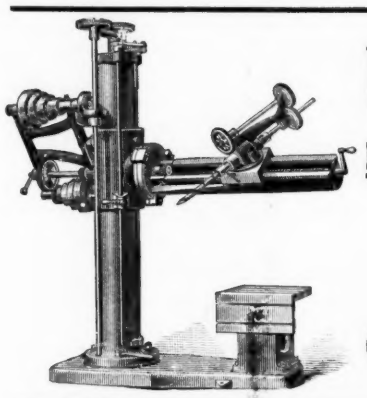

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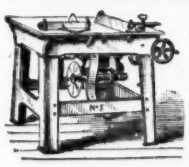

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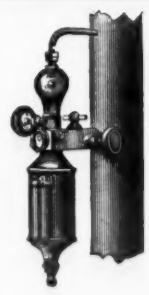

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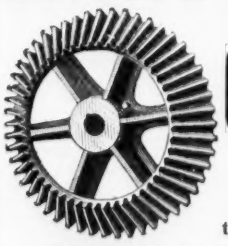

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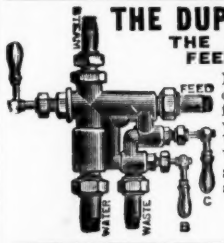

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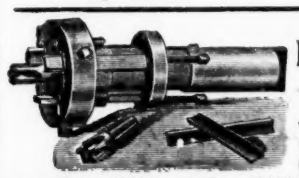

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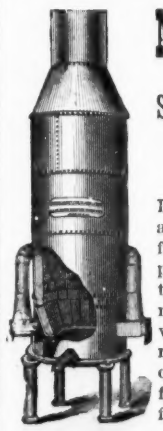

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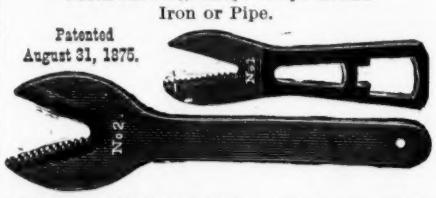

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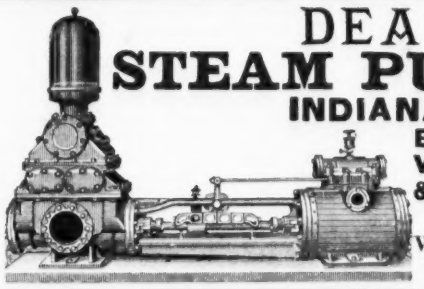

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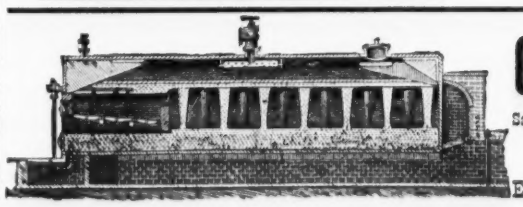

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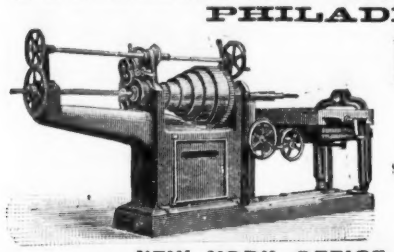

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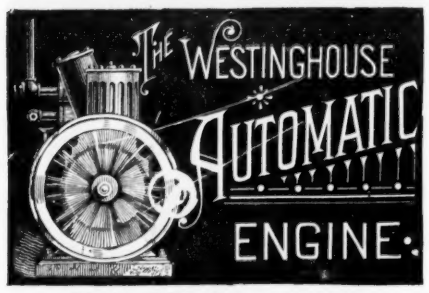

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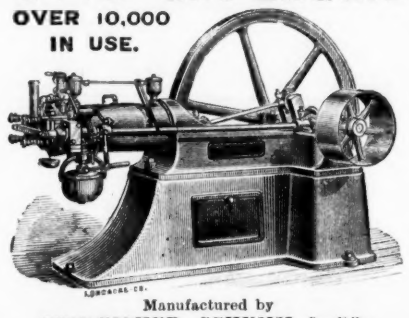

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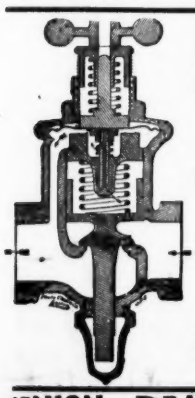

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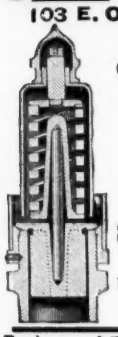

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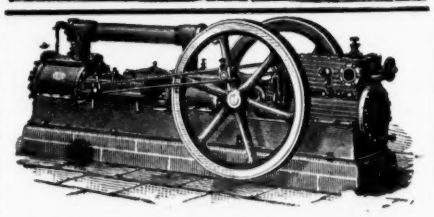

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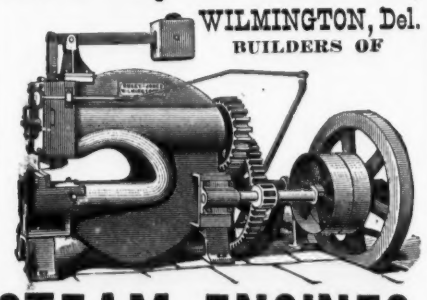

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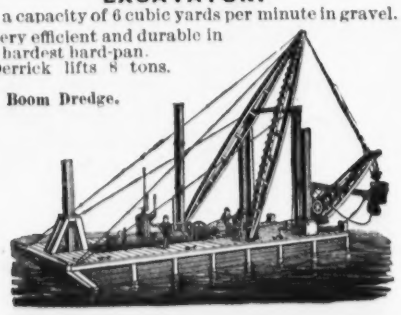

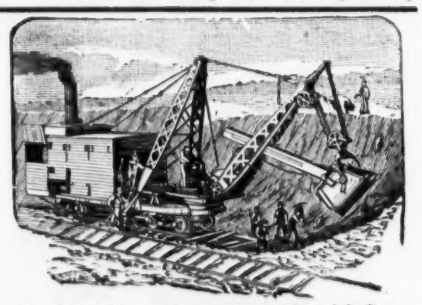

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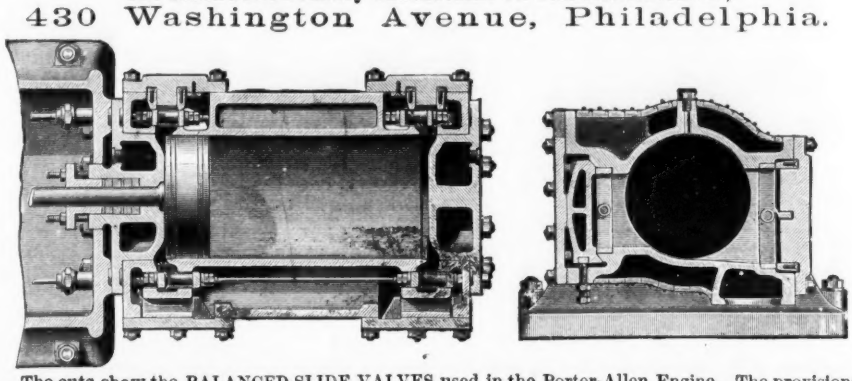

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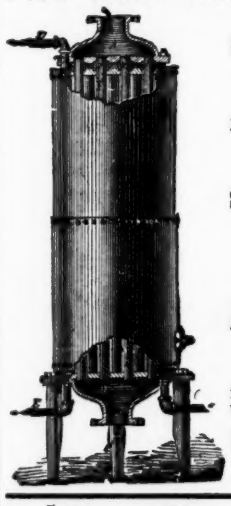

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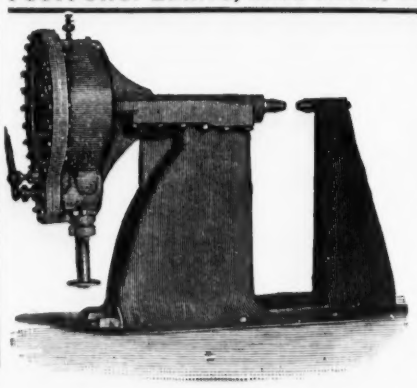

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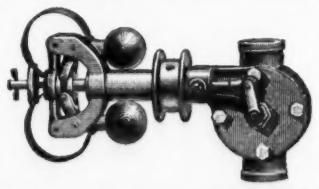

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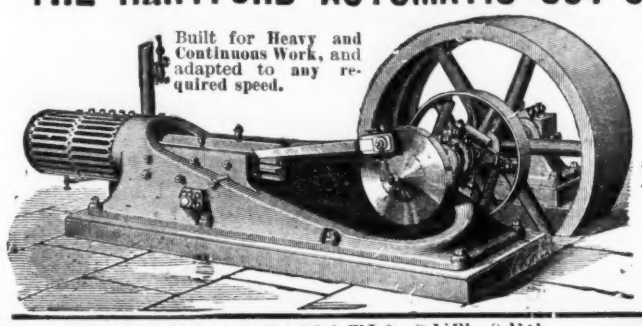

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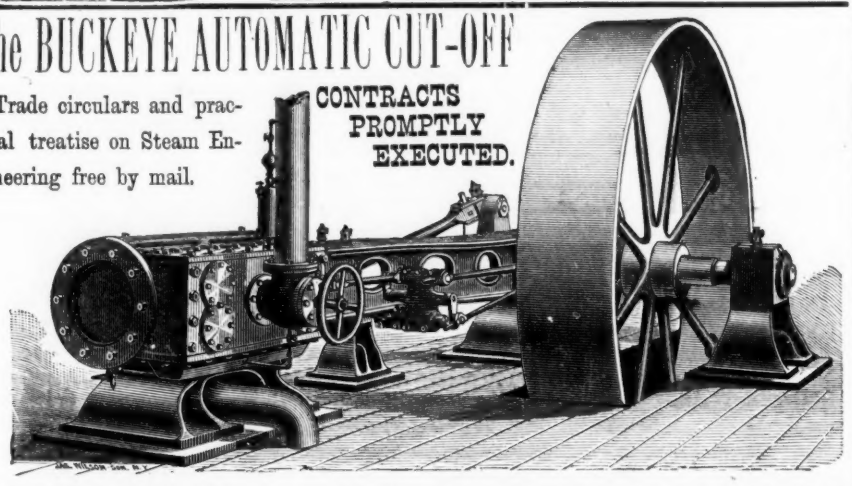

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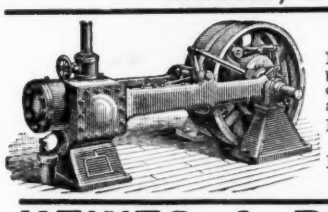

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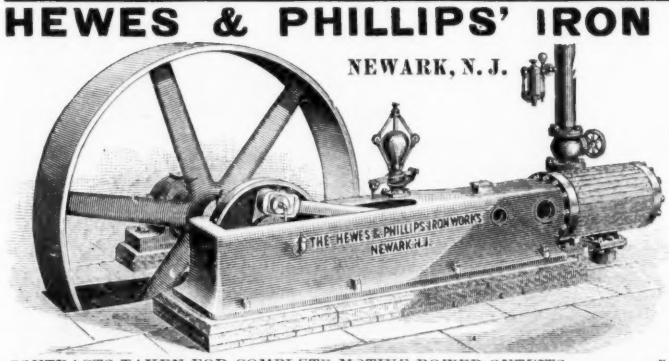

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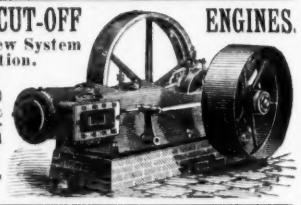

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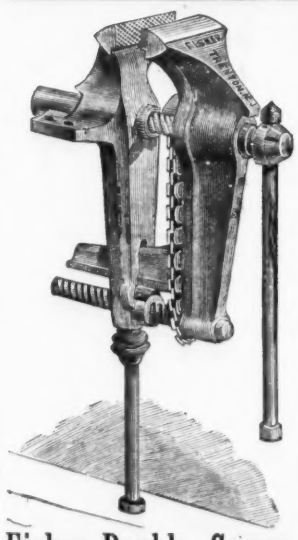

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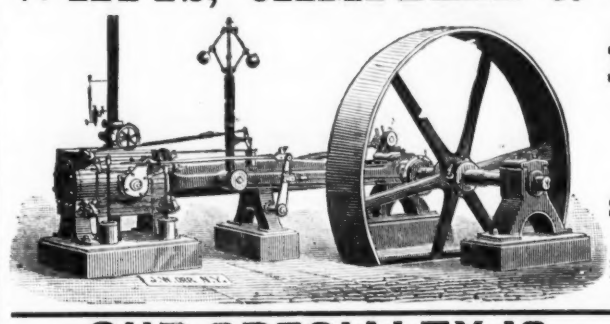

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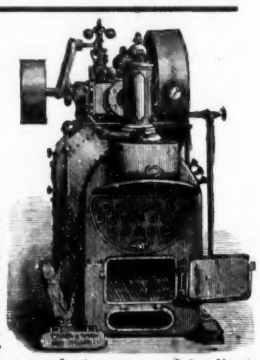

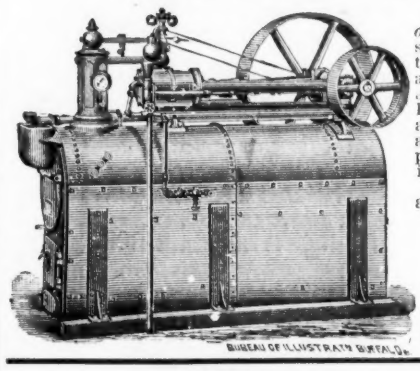

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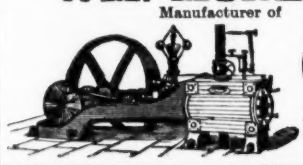

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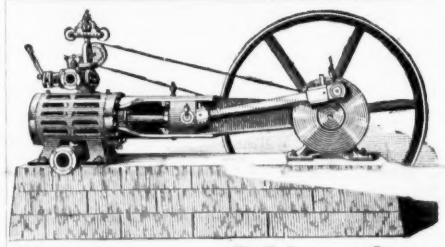

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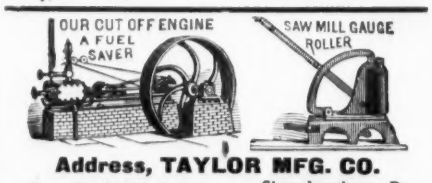

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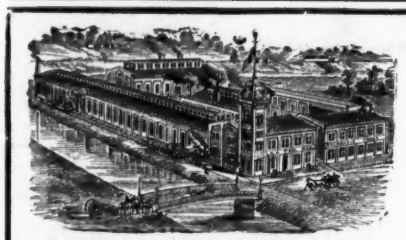

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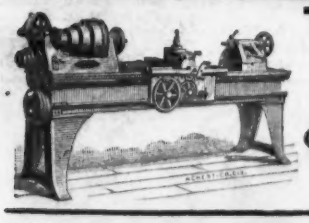

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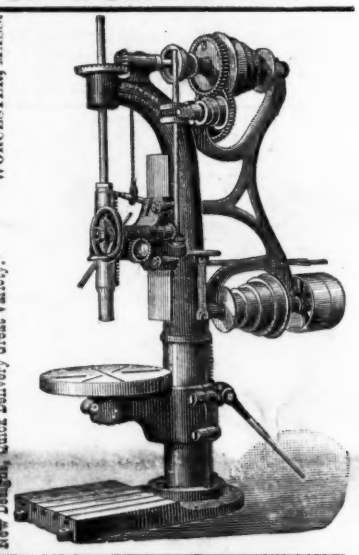

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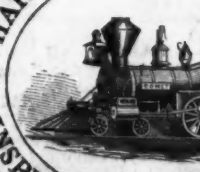

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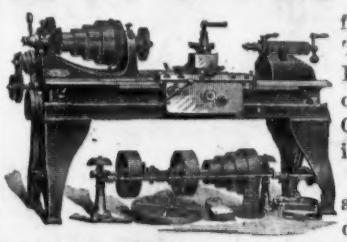

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